Army, Marine Corps, Military Airlift Command, Tactical Air Forces, Strategic Air Command

NIGHT

Multi-Service Night and Adverse Weather Combat Operations

JANUARY 1991

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PREFACE

PURPOSE

The purpose of this publication is twofold:

- To examine and identify existing strengths and limitations of US forces involved in night and adverse weather combat operations.
- To enhance the development and joint use of tactics, techniques, and procedures for conducting night and adverse weather combat operations.

SCOPE

This publication focuses on each service's planning and coordination requirements and their capabilities and limitations for operating jointly at night and during adverse weather. It uses accepted joint doctrine and terminology as its foundation and incorporates current service tactics, techniques, and procedures. It can be either a source document for developing multi- and single-service manuals, publications, and curricula or a stand-alone document.

APPLICABILITY

Tactical forces of the Army, Marine Corps, and Air Force may use this publication. It has been developed for all planning and warfighting personnel.

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Identified Curricula.

Army-Air Force Joint Ground-Air Operations. FM 100-XX/AFM 2-XX.

Mission Employment Tactics, Tactical Employment, General Planning and Employment Considerations. MCM 3-1, Vol I and applicable MDS vols.

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Multi-Service Night and Adverse Weather Combat Operations

Night

EXECUTIVE SUMMARY

US military forces must be able to operate jointly during night and adverse weather conditions. Currently, our forces have an advantage over threat forces in technological capabilities for night and adverse weather combat operations. We must train jointly with these technological capabilities so that we fight efficiently and effectively together. This publication identifies and examines the existing strengths and limitations regarding night/adverse weather combat operations and is a single source reference for fielded multi-service night and adverse weather systems.

This publication is organized in two parts: Part One, Combat Environment and Part Two, Combat Operations. It also has appendixes. Part One covers general operational considerations of night and adverse weather. It also discusses the influence of these operational considerations as they apply to threat operations. Part Two discusses the impact of night and adverse weather on ground, maritime and amphibious, air, and special operations. The appendixes provide specific information on friendly and enemy night/adverse weather systems, including their capabilities and limitations.

PART I
COMBAT ENVIRONMENT

Operational Considerations

This chapter describes the potential effects of night and adverse weather on personnel and equipment. US and allied forces need to know the effects these conditions have on personnel and equipment in order to make the best use of friendly capabilities and threat disadvantages.

Threat Operations

US and allied forces also need to know the threat capabilities to operate at night and during adverse weather. This chapter describes Soviet threat doctrine, training, capabilities, and forces available for night and adverse weather operations on land, on sea, or in the air. This chapter does not, however, intend to imply that our only threats for night and adverse weather operations are the Soviets or Warsaw Pact forces.

PART II
COMBAT OPERATIONS

Ground Operations

US ground forces participate in some portions of all operations. This chapter addresses the effects of night and adverse weather on major functions in battlefield operations: intelligence, maneuver, fire support, engineer support, air defense, combat service support, and command and control.

Maritime and Amphibious Operations

This chapter primarily addresses planning for maritime and amphibious operations, including the roles of sea, air, land teams (SEALs), landing force reconnaissance units (LFRUs), and the use of helicopters. It also addresses the advantages and disadvantages of conducting maritime combat operations during night and adverse weather.

Air Operations

This chapter considers the factors involved in planning air support operations during night and adverse weather with attention to the means of identifying targets and the threat to aircraft. It evaluates operational capabilities and limitations of fighter/attack aircraft, airlift, and strategic bombers.

Special Operations

US special operations forces (SOF) have certain capabilities and limitations when conducting special operations missions at night and during adverse weather. The equipment and missions of each service's SOF require consideration when planning general special operations.

APPENDIXES

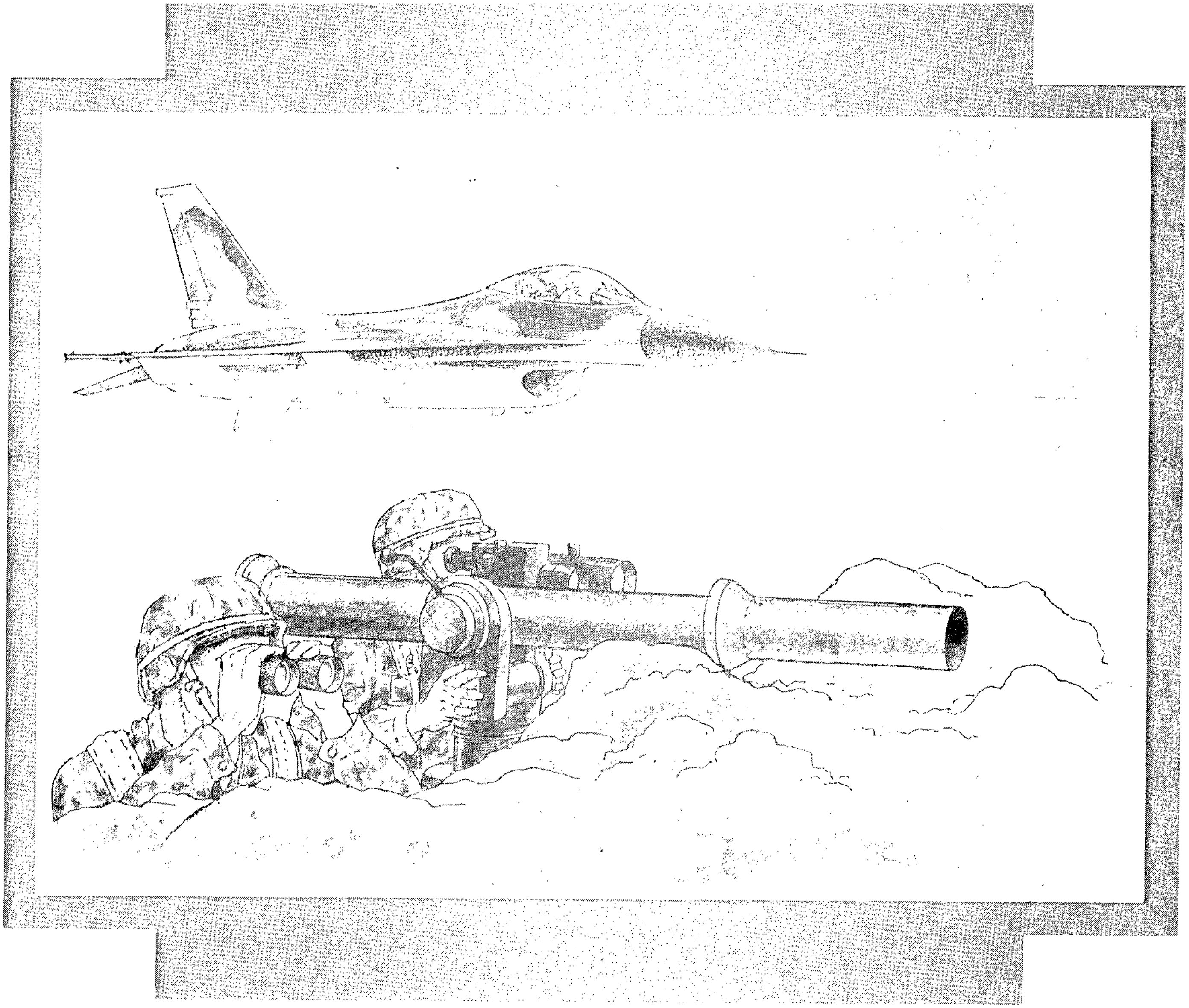
Appendix A shows the effects of weather conditions on sensor systems throughout the electromagnetic spectrum. It also provides tables to show the bands of the electromagnetic spectrum on which particular weapon systems operate. Appendix B provides heat stress and wind chill tables to show adverse weather effects on personnel. Appendix C details recently developed tactics using US laser spot-tracker (LST) systems to provide aircraft with a significantly increased night, low-threat close air support (CAS) capability. Appendix D provides data on US ground-force weapons systems, and Appendix E, on US aircraft and weapons systems. Appendixes F and G provide corresponding data on Soviet weapons systems and aircraft. Appendix H describes US multi-service weather support capabilities. And finally, Appendix I provides a brief description of the Global Positioning System (GPS).

PART ONE

COMBAT ENVIRONMENT

To fight effectively, commanders and their staffs must know how to exploit the opportunities offered by night and adverse weather while minimizing its adverse effects on their operations. Night and adverse weather conditions have the potential to affect every combatant, piece of equipment, and operation. It affects the decisions of both forces.

Part One of this manual discusses the operational considerations of night and adverse weather on personnel and equipment. In addition, Chapter 2 specifically describes the effect of night and adverse weather on threat ground, naval, air, and special operations.



CHAPTER 1.

OPERATIONAL CONSIDERATIONS

Night and adverse weather may have significant impact on combat operations. These conditions limit the efficiency of personnel and the effectiveness of weapons systems; transportation, maintenance, and resupply systems; electro-optical (E-O) target-acquisition designation systems (TADS); and target-designation systems and surveillance systems.

NIGHT

Night is the period from the end-of-evening civil twilight to the beginning-of-morning civil twilight. Night complicates all aspects of combat operations and presents challenges, problems, opportunities, and risks. Night, unlike adverse weather, is predictable. Therefore the detailed plans required for success at night can be thought out well in advance of operations. Following are the conditions planners should consider and the effects of night operations on personnel and equipment.

Conditions

Temperature and Humidity

Most daytime weather phenomena can also occur at night. However, certain characteristics occur more frequently or only at night. Temperatures become cooler, especially near the ground, resulting in low-level temperature inversions (that is, temperatures increase rather than decrease with altitude). Although absolute humidity will not change until moisture condenses as dew, relative humidity increases as the temperature decreases at night. Water content of the air does not change until moisture condenses as dew or fog. At low temperatures, high relative humidity has little water content and, therefore, little impact on forward looking infrared (FLIR) devices. Absolute humidity is a measure of the actual water content of the air. At high temperatures near a water source, high absolute humidity degrades the range of FLIRs because of the high water content. FLIRs are also affected by infrared (IR) crossover which is discussed under the E-O systems section of this chapter.

Winds

Winds may vary significantly. They can reverse direction from onshore during the day to offshore during the night; or they can change from upslope to downslope where land-sea breezes and mountain-valley breezes circulate.

Ceilings and Visibility

Ceilings and visibility can also vary. With low-level temperature inversions, low stratus clouds or fog can form. These clouds and fog can lower ceilings and surface visibilities for several hours after sunrise until solar heating overcomes the temperature inversion.

Obscurants, such as dust or smoke, may layer the battlefield during the more stable conditions found at night also causing lower visibility. The resulting cloud lies close to the ground or forms a canopy several meters above ground. At night, temperature inversions, light winds, and a stable lower atmosphere are typical. They cause obscurants to linger in the target area much longer than during more turbulent, windy, and unstable conditions during daylight. To adjust for lingering obscurants during night operations, planners should always know the current and forecasted weather conditions.

Effects On Personnel

Darkness may impair visual clarity, field of view (FOV), and depth perception. The eyes adapt to darkness in varying degrees and at different rates. At night, unaided eyes usually cannot clearly identify people and objects but can recognize outlines. Since darkness diminishes color perception, the eyes may be able to distinguish only between light and dark colors. In addition, the pupils enlarge as the eyes adjust to darkness, allowing two to four times as much light to enter the eye. Exposure to sudden bright concentrated lights increases the damage to the eye.

The increased time required by personnel during night to operate equipment and to recognize, identify, or lock on to targets reduces the effectiveness of equipment and weapons. Also, the continual disruption of sleep patterns results in chronic fatigue and diminished physical and mental abilities. These conditions can cause intensified fear and feelings of isolation and decreased confidence. To help avoid these conditions, leaders must enforce a sleep plan that all adhere to. Planners must not overlook the effects of these conditions when considering night or continuous operations.

Effects on Equipment

Strong temperature inversions or reduced densities in the ionosphere limit electromagnetic propagation by radio and radar. The ionosphere is that part of the earth's atmosphere that is responsible for long distance radio transmissions. For units relying on long-range high-frequency (HF) communications, ionospheric changes at night require lower radio frequencies (RFs) than those required for daytime communications. Nighttime land breezes can also cause irregular propagation of radio, radar, or sound waves, giving false returns and targets or causing zones along coastal regions where radio communications cannot be established. Acoustic sensors, however, can be more effective during the calmness of night because of less natural background noise. Any sound-ranging techniques based on a fixed rate of the speed of sound, though, can lead to erroneous distance determinations since sound travels slower at night than during the day.

ADVERSE WEATHER

Adverse weather is that weather which generally restricts or impedes military operations. Commanders knowledgeable enough to exploit weather effects have benefited, while others have suffered when they chose to ignore weather or fought unprepared for adverse weather. General Eisenhower once said, "Bad weather is obviously the enemy of the side that seeks to launch projects requiring good weather or the side possessing great assets, such as strong air forces, which depend upon good weather for effective operations." This observation holds true even today.

Historically, weather has played a crucial role in warfare. The uncertainties of weather present major challenges to commanders when planning and executing joint operations. The inaccuracies inherent with forecasting make joint communications especially crucial to mission success. The air commander must know the current and forecasted weather in the target area, and the ground commander must know the ability of his supporting air assets to launch, strike, and recover.

Force modernization has brought a new family of sophisticated, precision-guided munitions, and E-O weapons into the inventory. These systems are very sensitive to weather that disrupts electromagnetic propagation. Therefore, commanders should plan to use these weapons during those conditions where they can be most effective (see Appendix A). Commanders should be familiar with any environmental conditions which degrade their combat employment options.

Army FM 34-81 / AFM 105-4[1], is an excellent source for additional planning considerations.

1 *Weather Support for Army Tactical Operations*

Conditions

Poor Visibility

Poor visibility may enhance military actions by concealing forces and maneuvers, thereby helping forces achieve surprise. Conversely, poor visibility creates potential difficulties with cohesion, command and control, and reconnaissance, surveillance, and target acquisition.

Wind

During strong winds, the upwind force usually has the advantage in using nuclear, biological, and chemical (NBC) and conventional weapons. In addition, strong winds can blow dust, sand, smoke, rain, and snow on the downwind force, thereby reducing visibility, damaging equipment, and decreasing mobility. However, strong winds can negate the use of smoke screens because they rapidly dissipate the smoke.

Water

High waves. Rough seas, especially those with high waves that have short periods (small intervals between waves), can--

- Decrease a ship's speed and maneuverability.
- Degrade the accuracy of naval gunfire.
- Impair personnel by causing sea sickness.
- Hinder aircraft launching and recovering on aircraft carriers.
- Wash equipment and/or personnel overboard.

High wave heights can also change into high surf breakers and stronger littoral currents, depending on the topography of the sea floor. Hazards to landing craft increase with increasing breaker heights. Agitation and mixing during rough seas also curtail underwater operations by decreasing visibility and increasing bioluminescence. Mechanical mixing from high-wave action can also influence the subsurface temperature-salinity structure and, consequently, can affect the sound-speed profiles critical to sound ranging or dispersion.

Currents. Strong, wind-driven currents can either degrade or, when exploited, enhance surface and subsurface amphibious operations. They can also adversely affect fuel consumption, en route time, and directional control.

Water pileup. In bodies of water that are nearly enclosed, such as the Red Sea and Persian Gulf, prolonged strong winds from a constant direction can cause the wind-stress effect known as water pileup, which is analogous to storm surge along open coasts.

Evaporation ducting. A deep evaporation layer, along with clear skies, high temperatures, and strong winds can create evaporation ducting (0 to 200 feet). This enhances surface-to-surface radar, ultrahigh frequency (UHF) communications, and electronic warfare (EW) support measures ranges. However, across the duct, evaporation will create large ground-to-air, air-to-air, and air-to-ground gaps in radar, UHF, and EW support measures coverages that a military force knowledgeable of these effects can exploit. Intense evaporation can also influence the subsurface salinity structure, thereby affecting acoustic propagation.

Upwelling. In coastal areas, a sharp reduction in sea surface temperature due to upwelling causes moisture saturation in a shallow layer, resulting in fog and poor visibility. Upwelling also influences the subsurface temperature-salinity structure, thereby affecting acoustic propagation.

Precipitation

Precipitation significantly affects the state of the ground, visibility, and personnel effectiveness. Areas become impassable, personnel are uncomfortable, chemical and biological agents become diluted (but can be localized in hot spots), supplies in storage deteriorate, and mines lose their effectiveness. Snow and rain degrade IR and visible spectrum weapons and surveillance systems. Snow and ice limit radio antenna effectiveness, aircraft carrier flight deck launch and recovery equipment, and takeoff and landing operations on icy runways.

Clouds

Clouds limit slant-range visibility and natural illumination by the moon and stars, which in turn degrade image-intensifying night-vision devices (NVDs). Low cloud ceilings degrade the effectiveness of present laser systems by reducing the ability of precision-guided weapons to acquire the laser signal in time to adjust to the designated target. Scattering of laser light in clouds or fog may make the beam visible. Friendly and enemy air operations, such as close air support (CAS) and aerial resupply, are less effective with low ceilings and extensive cloud cover. However, clouds increase effectiveness of artificial illumination by reflecting the light back onto the battlefield.

Temperature and Humidity

Temperature and humidity extremes reduce personnel and equipment capabilities (see Appendix B). Electronics are susceptible to high temperature and humidity, while mechanical devices are vulnerable to very low temperatures. Consequently, tactics that are effective in one climatic zone may be ineffective in another.

The persistence of a smoke screen depends on the temperature gradient. Smoke lingers during temperature inversions which occur on clear or partially clear nights and at early mornings until about an hour after sunrise in the summer. In the winter, temperature inversions may take several hours to break. Smoke dissipates very rapidly under unstable conditions which occur during the heat of a clear day.

Smoke is more effective with high humidity levels. Very high humidities can double the effect of white phosphorous smoke.

Effects on Personnel

Weather impacts significantly on individuals. The primary adverse physiological effects are inefficiency and discomfort. However, prolonged adverse weather conditions can result in psychological impairment of judgment and performance. Poor visibility during adverse weather can lead to disorientation and the fear of being isolated. Prolonged exposure to intense sunlight, especially in a snow, dust, or water environment, can lead to sunburn, impaired vision, or chronic night or snow blindness.

Cold

During extremely cold temperatures, carrying out tasks takes up to five times as long as on a day with average warm temperatures. Cold weather increases evaporative loss of body water and requires forced drinking to avoid dehydration. Personnel must have a greater caloric intake to maintain body temperature. They must be forced to endure the cold and to maintain regular bowel movements under field conditions. Without proper clothing, personnel can get frostbite, which can cause incapacitation and casualties. In addition, cold water temperatures markedly decrease survivability in the water.

Heat

Extremely hot temperatures can also cause dehydration, dramatically decreasing personnel effectiveness. A two-quart loss of body fluid causes about a 25 percent loss of effectiveness. With hard work and only half the daily water requirements, personnel become ineffective after about six hours. Wearing the chemical ensemble accelerates dehydration. Prolonged dehydration and exposure can lead to heat-related injuries or casualties. High humidity with high temperatures can decrease effectiveness, especially in closed quarters such as bunkers, armored vehicles, and ships at general quarters. See Appendix B for heat stress tables.

Wind

Flying objects and debris due to strong winds can severely injure or even kill personnel. High winds, combined with low temperatures, can cause frostbite to exposed skin in minutes, even seconds. Because personnel need proper clothing and shelter during periods of high wind chill, they require more time to accomplish routine duties. See Appendix B for a wind chill chart.

Snow

Personnel become exhausted rapidly while walking or working in deep snow. Even minor wounds can become fatal if injured personnel remain in the snow or cold. Cold, wet climates may cause problems with such things as trench foot, pneumonia, and skin diseases. Discomfort and increasing fatigue diminish personnel effectiveness. Laser reflections off ice or snow may cause unintended results.

Lightning

Lightning can severely injure or kill personnel. It may also cause temporary hearing loss if personnel are not wearing headphones or hearing-protection equipment. Personnel, especially aircrews, operating equipment can experience flash blindness for up to 30 seconds after a lightning flash.

Effects on Equipment

Weather can degrade performance and cause external or internal damage to all types of equipment. Commanders must consider the impact of these effects on friendly and enemy operations. Following are significant effects on generic types of equipment.

Aircraft

High temperature. High temperatures reduce air density and therefore reduce the aerodynamic lift, engine thrust, and horsepower. Consequently, the maximum allowable gross weight, climb rate, and service ceiling are reduced, and engine power requirements and takeoff and landing rolls are increased. For large aircraft engaged in low-level flight operations, such as terrain masking, high temperatures may require flying at higher altitudes or decreasing aircraft cargo load to meet required climb gradients.

Wind. Strong crosswinds affect directional control and may result in longer takeoff rolls, especially for large aircraft and during poor runway conditions (water, snow, ice). Strong gusty winds can be hazardous to vertical-lift aircraft during start-up and shutdown. They can also cause mechanical turbulence over rough terrain, especially for light aircraft and unmanned aerial vehicles. Low-level wind shear reduces aircraft performance and safety. If wind shear or a microburst occurs while the aircraft is in high drag close to the ground, the results can be disastrous.

Updrafts and downdrafts can cause severe turbulence, resulting in airframe damage and aircrew and passenger injury. Turbulence can be described as convective, mechanical, mountain wave, clear air, or vortex wave. Its effects range from a few annoying bumps to severe jolts that can cause loss of control (including roll due to aircraft-wake turbulence) and structural damage.

Blowing dust and sand can degrade engine performance by causing internal damage and by clogging filters. The particles sandblast external surfaces and can jam exposed moving parts. Helicopter brown-outs are a possibility in hovering flight.

Lightning. Lightning strikes can cause structural damage as well as partial or total failures to electrical systems. Under certain conditions, lightning strikes can also cause catastrophic fuel vapor explosions.

Precipitation and icing. Hail larger than a half inch in diameter can cause significant aircraft damage in a few seconds. Deep, powdered snow degrades terrain-following radar signals. Excessive rain, snow, or ice on the runway causes loss of traction and directional control. When helicopters hover near the ground or land vertically, they blow loose snow, causing loss of visibility due to white-out.

Ice and snow accumulation on aircraft alter aerodynamic characteristics. They reduce lift and increase weight, drag, and stall speed. Ice accumulation on exterior movable surfaces affects aircraft control. On propellers, it decreases efficiency and can result in severe vibrations that dangerously stress the propeller and engine mounts. Ice in the air intake can severely restrict air needed for combustion and can damage the engine. Ice formed on static pressure ports can cause inaccurate indications of altitude, air speed, and vertical velocity. Ice on radio antennae can result in the loss of radio communications. Windshield icing reduces visibility. Ice formation on main rotor or antitorque systems can produce critical vibrations, reduced efficiency and control, and loss of available power to a level where safe landings cannot be assured. Ice fog caused by one aircraft landing or taking off can obscure the vision of the following aircraft.

Humidity. Continuous high humidity can induce external and internal corrosion and fungus growth and can also reduce air density critical to vertical-lift performance.

Vehicles

Cold weather operations require use of special grease, lubricants, and antifreeze. A six-inch depth of frozen ground may be required to support heavy vehicles in wet or soft soil areas during off-road travel. High temperatures increase fuel evaporation rates, resulting in gum formation and clogged filters.

Excessive rainfall and snowfall reduce speed, restrict movement, or completely immobilize vehicles. Fuel consumption significantly increases when operating vehicles in rain-soaked soils and in snow.

Direct-Fire Weapons

Low temperatures can degrade ballistics because lower powder temperatures reduce muzzle velocity. The maximum firing range decreases as temperature drops. Extremely cold temperatures can cause barrels to deform, decreasing first-shot accuracy. At -40 degrees Fahrenheit and lower, muzzle blast may cause ice fog which obscures the location of the gun tube. Ice fog that forms behind a missile when fired can obscure the gunner's vision of the target and reveal the firing position.

Indirect-Fire Weapons

Strong and gusty winds with surface or vertical profiles lower first-shot accuracy and make registration more difficult. Strong winds disperse sound and reduce sound and flash ranging used to locate a sound source (weapon firing, projectile burst). Frozen ground inhibits emplacement of howitzer spades which results in longer emplacement times and reduces weapon system responsiveness.

Conventional Munitions

Deep snow and mud reduce blast and fragmentation effects for point-detonation munitions, including mines. Heavy precipitation can also cause premature detonations. Refrozen or melting snow can interfere with mine fuses. Snow usually smothers smoke canisters and may reduce the effects of white phosphorous (WP) shells.

NBC Munitions

Temperature. High surface temperatures affect the evaporation rate of liquid chemical agents. Temperature gradients affect dispersion, persistence, and the height at which chemical or biological agents or smoke should be released. Agents released during an inversion temperature gradient are more persistent than those released during either a neutral or unstable condition.

Humidity. High humidity levels increase the effectiveness of some chemical agents while reducing the effectiveness of others. The effectiveness of biological agents varies depending on humidity level and type of agent. Blister agents are most effective in hot, humid climates. The best relative humidity level for using a biological agent aerosol depends upon whether the aerosol is disseminated as wet or dry. A high relative humidity is favorable for a wet aerosol because it retards evaporation of the small droplets containing the microorganisms. However, a low relative humidity is favorable for dry agents. Most toxins are more stable than pathogens and are less susceptible to the influence of relative humidity.

Wind. Wind speed and direction determine the dispersion path and radioactive fallout patterns. Strong winds will decrease chemical agent persistence.

Precipitation. Heavy rain can wash agents out of the atmosphere into low spots and water supplies. Radioactive fallout can also be washed out and form nuclear hot spots. Snow may cover certain liquid agents and render them ineffective.

Clouds. A cloud cover enhances the thermal effects of a nuclear burst below the clouds. Thermal and electromagnetic pulse effects are reduced if the burst is above the clouds.

Radio Communications and Radar Systems

Temperature and humidity. High temperatures and humidity adversely affect electronic circuits. Very cold temperatures can snap cable lines and decrease battery life. Temperature and humidity inversions can cause radar ducting that results in false radar returns and fading of tropospheric signals from troposcatter equipment.

Precipitation. Heavy precipitation can block troposcatter transmissions. It attenuates radar energy; single-channel amplitude modulation (AM) or frequency modulation (FM) radio; short-range, wide-band radio; and line-of-sight (LOS) communications, thereby reducing ranges. Precipitation also produces radar clutter and obscures echoes. Ice can degrade antennae capabilities as well as break wires and antennae. Snowfall covering satellite dishes can absorb outgoing and incoming signals of satellite communications (SATCOM).

Thunderstorms. Thunderstorms can interfere with radio and wire signals (especially HF signals), produce background noise, damage equipment, and disrupt synchronization for data transmission.

Ionospheric irregularities. Nighttime ionospheric irregularities can induce clutter and complete signal fadeout of very high frequency (VHF), FM, and HF signals as well as degradation of over-the-horizon backscatter radar. HF effects include irregular propagation, increased radio noise levels, flutter fading, transmission distortion, and a decrease in usable frequencies. LOS communications using VHF frequencies can experience increased noise and interference, bit error rates and loss of signal lock-on for navigation systems.

Wind. Wind blows dust and sand that can degrade communications equipment, especially radio equipment, by clogging filters and fans. The clogging causes the equipment to overheat which, in turn, causes internal damage to electronic components.

Electro-Optical Systems

Nonelectromagnetic effects, such as turbulence, icing, lightning, electrical charge buildup, and aerosol pitting may affect E-O systems. Turbulence can break signal lock-on. Icing can alter aerodynamic characteristics and coat sensor covers, rendering them useless. Lightning strikes and electrical charge buildup can create transient currents or can fuse circuits. Sensor covers can also deteriorate from pitting when exposed to large amounts of aerosols.

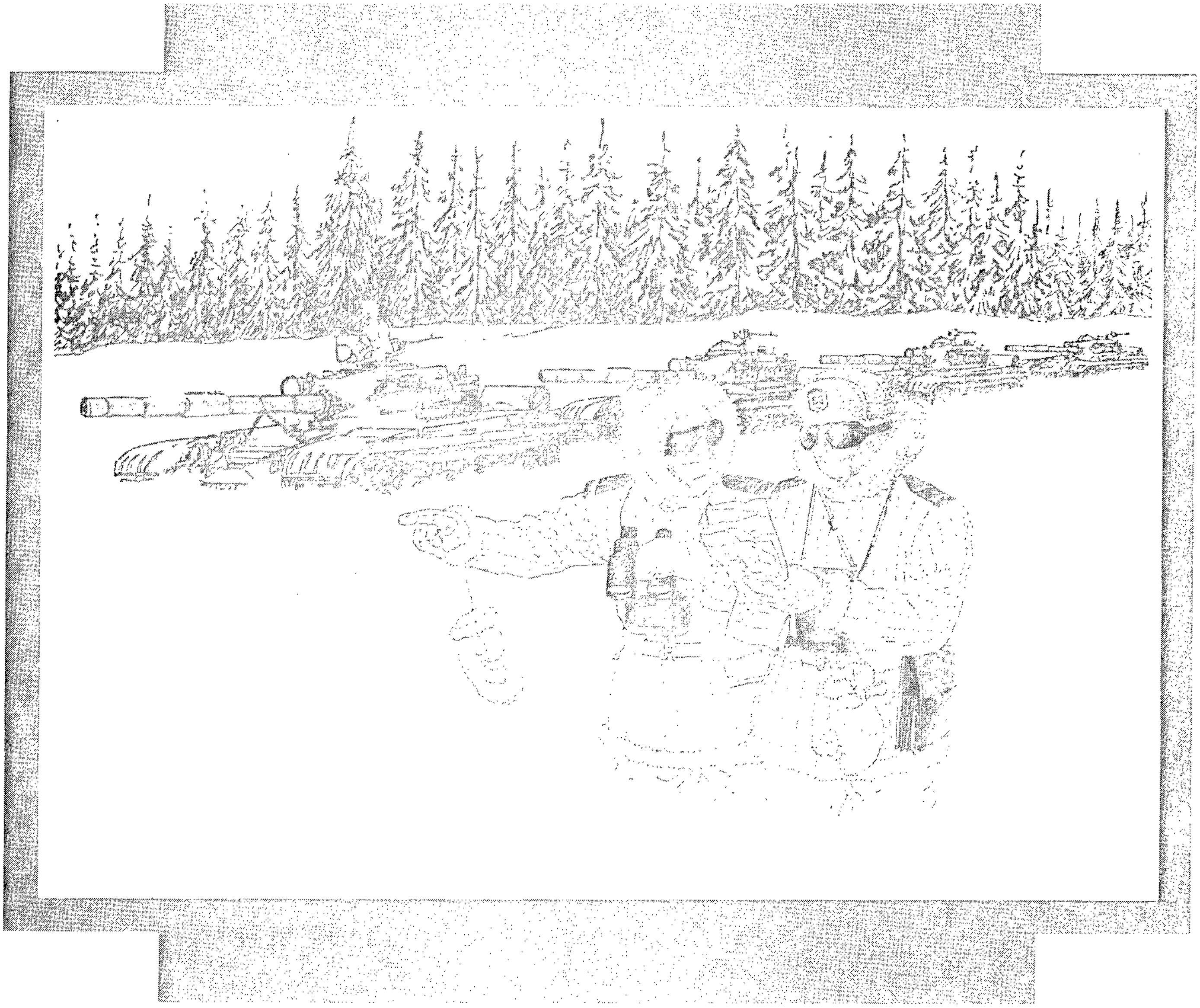
The ability of an E-O system to *see* is directly related to how well electromagnetic energy propagates through the atmosphere. Appendix A lists environmental sensitivities as a function of wavelength. Any smoke or obscurant in sufficient quantity will block both near and far thermal IR systems. Hydroscopic smokes, such as white phosphorus, are more effective than oil or diesel smokes in blocking thermal IR systems.

Heat and dust from high explosive rounds and fires on the battlefield can temporarily disrupt IR systems. Snow defracts the laser beam of laser target designators (LTDs), reduces their range, or makes them ineffective. Snow spreads a very thin visible laser beam into a wide band similar to the way light spreads in fog. The nearly invisible beam can become a broad band, even in light snow.

Temperatures of targets and objects on the battlefield at night are also important for the use of thermal sights and FLIR devices. A difference in temperature or thermal contrast is required for these devices to see a target. Normally, heating and cooling is at a different rate for the target and background. Twice a day, in the morning and evening, targets without internal heating come to relatively the same temperature as the background. At this point thermal crossover occurs and the thermal device does not have the capability to see the target. Time of thermal crossover may be only a few seconds when the morning sun strikes a target, or for several minutes on cloudy adverse weather days, depending on the threshold temperature's contrast required by the thermal device. Tactical decision aids can be used to predict these temperature differences for planners and estimate length of thermal crossover periods.

In addition, the following can significantly alter the thermal contrast of a target to its background, making it harder for the IR sensor/tracker to detect and lock on:

- High absolute humidity.
- Cloud cover (especially a low, thick cloud cover).
- High wind speeds.
- Rainfall or snowfall.



CHAPTER 2.

THREAT OPERATIONS

Night fighting has been, and is today, a planning factor for a variety of threats facing United States forces. For example, the successes of Soviet forces in night offensives during World War II reinforced their desire to conduct military operations at night. Today, the Soviets believe that the increasing emphasis on night fighting in the West, coupled with the West's technological lead in night-vision equipment, justifies their increased commitment to this type of warfare. Additionally, Soviet client states and Third World revolutionary groups emphasize night attacks as an essential part of their tactics. Although numerous threats exist at the unconventional warfare level, this chapter focuses primarily on Soviet operations, technology, and doctrine used at the conventional level.

This chapter does not intend to imply that the United States will face a night and adverse weather combat situation against only the Union of Soviet Socialist Republic or Warsaw Pact forces. Adverse weather effects on friendly operations as described in Chapter 1 are equally applicable to all threat operations--Soviet or other. Many other situations will require night and adverse weather combat against a wide variety of potential enemy forces within the operational continuum.

NIGHT

Ground Force Operations

During full-scale war, nations will use conventional forces and conduct large-scale operations. In World War II, the Russians conducted night conventional operations more often and on a larger scale than any other combatant. Night combat accounted for more than 40 percent of Soviet combat time. Night attacks on a scale above regimental level usually occurred when Soviet forces had failed to take an important objective in daylight attacks. However, toward the end of the war, Soviet emphasis on momentum led to an increasing use of night operations to meet operational objectives in greater depths.

Today, the greatest nighttime threat from conventional forces are predawn attacks and night attacks that begin in the day and continue into the night. The Soviets most often launch predawn attacks two to three hours before dawn in order to provide maximum daylight for a successful mission. In Central European winters, visibility from this predawn period until a few hours after dawn is normally very low due to ground fog. Fog will have the greatest impact on our IR systems at the same time the Soviets plan to attack. They plan these attacks either to conclude before daylight or to commit the second echelon at dawn. Command and control problems make the Soviets hesitant to commit the second echelon during the night.

The Soviet night defensive operations closely resemble the daylight defensive operations. The Soviets use counterreconnaissance and tactical deception to prevent their enemy from determining the location of their units. They will use decoys and dummy positions to avoid detection, placing more observation posts in front of company positions than would be normally expected. Commanders will locate battalion command observation posts close to the forward line of own troops (FLOT) so they can conduct their own surveillance. Commanders will need to reinforce their night defenses and to increase the density of fire in front of the forward area, as well as in sectors not occupied by friendly units.

According to Soviet writings, one apparently successful defense against a Soviet night operation is a comprehensive barrier plan by an opposing (Western) commander. Such a defensive tactic would seriously slow the Soviet night operation by causing it to rely on cautiously advancing tanks and infantry fighting vehicles (BMPs). While marking passage lanes, these vehicles would have to shift their artillery fires to suppress Western units forming the barrier. Loss of momentum is the most feared setback during a full-scale conventional attack under any conditions. Soviet forces will carry out night operations if such operations support or enhance mobility and tempo but will not if doing so would retard mobility.

Soviet doctrine indicates that chemical weapons could be used in a nonnuclear environment against an enemy whose chemical defense is weak or when their use would be particularly advantageous, that is, during night or adverse weather. Their doctrine also indicates chemical nonpersistent agents would be used across the front of a Soviet attack before a combat engagement. Persistent agents would be used deep within the enemy's rear and along troop flanks to protect advancing units.

Training

The Soviets have a comprehensive night-fighting philosophy, but their training and capability to conduct night operations still fall short of their doctrinal requirements. Observed Soviet night training amounts to only 15 percent of overall combat training. Within a Soviet regiment, one battalion may excel at night operations while another performs poorly. Training of Soviet commanders may be part of the problem, but that will improve with more emphasis at the military academy level. Doctrinally, Soviet motorized rifle and tank units are supposed to conduct about one third of their training at night. Such training, however, is often conducted poorly with short, stereotyped, and unrealistic training periods, and it is often not combat related.

The discrepancy between doctrine and practice is especially obvious in night movement training. The Soviets practice night movement, reorganization, and maintenance regularly. However, despite the availability of NVDs, they often use headlights and flashlights to help maintain control and orientation. March columns are often detected even when blackout lights are used.

The Soviets recognize these night-fighting considerations and, therefore, they avoid complicated maneuvers. They make allowance for slower maneuvers, use of more ammunition, and delays. They use deception operations at night as well as during the day.

The Soviet military press usually characterizes night attack with certain common features. The attacking force will be a combined-arms force organized into two echelons with a very strong first echelon. An artillery preparation conducted under full illumination will precede the attack. The initial assault on the enemy position will contain a dismounted element. A combat reconnaissance patrol will be sent out to locate the counterattack force, which will then be defeated by a combination of fire and maneuver. The second echelon or reserve will always enter the battle, either on the main axis or against the counterattack. And finally, the attacking unit will be prepared to continue offensive operations at dawn.

Preparation

Preparation for night attacks requires daylight and, if time permits, nighttime reconnaissance. For example, Soviet battalion commanders may meet with their subordinates at observation points to designate reference points–those terrain features visible at night and those to be illuminated. They will lay out control lines and unit boundaries. They will assign azimuths of attack so their soldiers can use the directional gyroscopes in their tanks and other armored vehicles.

Where possible, Soviet engineer units install stakes with one luminous side to mark boundaries. These can designate points at which companies should go into platoon columns and lines, identify contaminated areas, or establish lanes through minefields. The units place two or three marker stakes every kilometer so as to be visible only from the line of march. Artillery, mortar, and hand-held illumination options are usually prepared to fire on order or according to plan. The Soviets generally mark their tanks and armored vehicles on the rear of the turrets with white paint or cloth. They use masked rear lights and colored lenses to differentiate units. Infantrymen may wear white arm bands or carry colored lights on their backs.

Execution

Soviet combat night missions use concealment, ambush, reconnaissance patrols, unconventional warfare (UW) missions, and missions beyond the FLOT by forward detachments and assault units. They carry out these missions with small groups specially trained for each operation.

Most Soviet night attack doctrine focuses at the subunit (battalion and below) level. Regiment level and above will generally use illumination during the attack.

Using a period of darkness prior to the time for artillery preparation or attack allows the Soviets to use the element of surprise. If illumination is abundant, unit frontages and intervals are probably the same as for a daylight attack. With less illumination, during adverse weather or on difficult terrain, units may attack on narrower frontages and in tighter formations. Second-echelon units will follow the first echelon at a close interval. Soviet troops will normally attack dismounted unless the terrain is open, enemy defenses have been effectively neutralized, and illumination is abundant. Dismounted troops use the line formation. Advancing tanks, infantry, and armored vehicles will decrease their line intervals at night.

Fire support. An attack against a defending enemy will usually include an artillery preparation phase. That phase may begin with the initiation of illumination at a designated time or on call (upon receipt of enemy fires). One platoon of each artillery battalion will fire illumination missions. Such illumination can assure effective direct fire to distances up to 3,000 meters. Target acquisition support for artillery fires includes radars, flash and sound-ranging systems, and reconnaissance patrols. Helicopters can also support night operations.

Movement. Movement is the predominant night activity. Soviet troops will also carry out major repair and resupply activities at night where possible. During tactical movement, they will employ march security and night security, as well as light and sound discipline. Commanders control use of active IR devices. They will have infrequent 20- to 30-minute halts but no long halts. During halts, the columns will displace off movement routes. Traffic controllers at road junctions will direct movement.

A wheeled-vehicle column normally travels at 25 to 30 kilometers per hour. Except during observation periods, tanks would move with closed hatches. Forces may conduct nighttime river crossings. During a maneuver battalion night march, security units will operate closer than during the day (5 kilometers on flanks, 3 to 5 kilometers in the rear). March reconnaissance for battalions will range closer to the advance party (1.5 kilometers to 3 kilometers).

Control and security measures are similar to those for a night attack. Tanks will be marked with white patches and colored lenses. Trucks will use headlamps with blackout shutters (or IR filters on lead vehicles) but will drive without lights as much as possible. Truck taillights will have special lenses to enable following trucks to gauge their intervals. Towed artillery and trailers will have small clearance lights or reflectors.

The lead driver of each truck column and of the lead armored vehicle may use active IR driving aids. If their vehicles are so equipped, all drivers may use passive devices. Luminous stakes and traffic regulators with small blackout lights will be stationed at important junctions to mark march routes.

Command and control. Once attacks start, designated vehicles in each unit will fire colored flares, matching the color of its rear lenses, upon crossing phase lines. Marker or incendiary shells will designate boundaries. Artillery illumination or fires created by incendiary rounds may provide alignment markers or mark objectives for attacking units.

Use of flares. Soviet forces must consider the characteristics of the terrain when using flares. On even terrain or terrain sloping upwards toward an enemy, they will illuminate from behind. On terrain which slopes downhill toward the target, they will illuminate the front of the target. They will use illumination rounds close to the ground 50 to 100 meters in front of enemy positions to blind their opponent while avoiding illuminating friendly forces. Battlefield illumination may be continuous or intermittent. Because they reveal an operator's location, searchlights are turned on at 10- to 15-second intervals. Historically, searchlights have been used to impair, or *bloom*, night sensors; confuse enemy pilots; or just illuminate enemy aircraft to better focus ground fire. They may also use lasers for similar effects.

Use of NVDs. Soviet deployment and employment of NVDs lag one, and often two, generations behind the West. While some US forces are well equipped with passive light-amplification and thermal NVDs, many Soviet units still rely on active IR illumination, flares, flash- and sound-ranging systems, and radar for target acquisition. At present, the Soviets have fielded only limited numbers of passive light-amplification devices. Refer to Appendix F for illustrations showing some of the large inventory of Soviet NVDs.

Use of passive and IR vision devices. Soviet troops will use passive vision devices continuously. They will fire weapons equipped with passive IR sights during the periods of darkness between illumination rounds. However, fog, heavy rain, and snow hamper these vision devices. Soviet snipers and *spetsnaz* often use passive devices because they do not use a laser designator, which can be easily detected.

Use of E-O countermeasures. The Soviets use terrain masking, decoys, corner reflectors, and jamming to degrade enemy radars. They give high priority to destroying enemy artillery and mortars that fire illumination. They use lasers, illumination, and smoke to assist their operations and blind the enemy. They may ferret out weapons equipped with passive NVDs by using decoys and feints which draw aimed fire without using illumination. Such weapons, particularly tanks and antitank guided missiles, are targeted for blinding by using smoke and illumination by flares and searchlights. Small-caliber antiaircraft guns and machine guns can shoot down enemy flares.

Naval Force Operations

Although limited Soviet nighttime naval training has been observed, Soviet naval forces can conduct night naval operations. They have low-light E-O, IR, and radar to provide target acquisition for air defense and short-range surface-to-surface weapons systems. Longer-range surface-to-surface missile systems will require nonorganic targeting, as the Soviets have not shown evidence of significant nighttime helicopter targeting operations. Most modern naval warfare is fought beyond the visible horizon, aided by electronic systems. Therefore, night naval operations are similar to daylight operations.

Air Force Operations

The Soviet air force is well equipped to conduct defensive operations over its own territory at night. Soviet fighter-bombers are equipped to conduct offensive and defensive counterair night operations. These aircraft have air-intercept radars and operate in an extensive early warning, ground-controlled intercept radar network. Missiles and guns without radar would not have a significant capability at night. The Soviets do not consider radar-equipped air defense artillery to be degraded by nighttime operations. See Appendix G for a list of Soviet aircraft capable of operating at night and in adverse weather.

Some Soviet air facilities do not have lighting and instead rely on runway markings. Soviet fighter-bombers can operate from grass strips which require little or no lighting and are difficult to detect. This capability can provide a large number of alternate air facilities.

Special Purpose Forces Operations

In almost all conflicts, friendly forces may encounter guerrillas, terrorists, saboteurs, and special purpose forces. Guerrilla forces can perform as conventional forces or special purpose forces with all types of missions.

Saboteurs can include enemy sympathizers, terrorist enemy agents, and unconventional warfare forces. Enemy movement and sabotage activities increase at night, because darkness aids concealment and surprise. High-priority, lightly defended targets are most likely to be selected for sabotage missions. To counter such activities, our forces need high levels of readiness and active defense measures.

The special purpose forces of the Soviets and of non-Soviet Warsaw Pact and some Third World nations are well equipped and trained for night operations. Soviet *spetsnaz* airborne and air assault units, and naval infantry regularly conduct night training exercises and emphasize employment at a higher level than conventional forces. Soviet *spetsnaz* forces are especially well equipped for night missions and possess the most effective NVDs of Western origin. Conventional units smaller than battalions may also conduct special purpose night missions that include reconnaissance, raids, ambushes, and target destruction.

The Soviet war in Afghanistan provides interesting information on what types of units have done most of the fighting and when they have done it. Not only have the *desantnive,* or air-landed forces (airborne or airmobile), done 80 percent of the fighting in this war, but they have also performed highly skilled night fighting. Even in this unconventional war, which may not remain atypical for Soviet forces, they perform night fighting in small units and require significantly more training than motorized rifle-type forces would expect to receive.

Are these elite forces successful? A recent Rand study on the war reports that "Most of the operations take place in the mountains and in formations no larger than a company. A VDV (airborne) company of about 90 men succeeded in attacking a Mujahideen position from the rear, climbing a mountain thought to be unassailable, and surprising the rebels by attacking fiercely at night." This seems to be a representative description of an unconventional operation, enacted by a small, unconventional force and founded on surprise.

ADVERSE WEATHER

During World War II, the Soviets used adverse weather to their advantage in both offensive and defensive operations. They learned that adverse weather, especially a hostile winter environment, serves well as an ally. They continue to train in cold weather today and can be expected to conduct conventional attacks in cold weather.

Ground Force Operations

Training

Soldiers can be taught and conditioned to use the winter environment to great advantage over a less prepared enemy. Conversely, if winter were to be treated like another enemy, they would be forced to fight on two fronts. Thus, the Soviets believe that physical exercise under cold conditions promotes their troops' adaptation to cold weather.

The war in Afghanistan suggests that recruitment of soldiers from subarctic regions for such operations has merit. In the high mountains, the Soviets have used Siberian and Altaic soldiers who are physiologically better able to handle extreme cold than their East European contemporaries.

The Soviets conduct rigorous training exercises in cold regions to familiarize their troops with survival problems. Their troops train to endure low temperatures and to perform their duties effectively in a state of physical and mental preparedness. The very success of Soviet cold weather operations derives from the preparedness of their troops to endure the difficulties and hazards of cold weather. Such tactical field training instills confidence in the soldiers' abilities to accomplish their missions no matter what the conditions are.

The Soviet training year is divided into two parts of the same length and importance--the winter and summer cycles. Winter training starts in October and culminates in full-scale exercises at division or higher level in February or March. Integrated cold weather and winter warfare training reportedly totals more than 200 hours per month. The Soviets stress the importance of detailed planning for winter operations, and all Soviet commanders, whether in garrison or field situations, abide by the Soviet preparedness maxim, "Winter comes in one day."

Equipment

For the most part, Soviet equipment is not human engineered. Heating and cooling systems are inadequate, even by Soviet standards.

Motorized vehicles encounter various problems under very low temperatures. Probably the most common and most serious is engine starting. The Soviets have coped with this problem by using compressed air starters and engine preheaters which operate by heating the engine coolant and oil. In those areas where cold weather may impede military operations, the Soviets have developed equipment, including over-snow personnel carriers, to assure that movement will be successful.

In arctic amphibious landing operations, amphibious vehicles can be fitted with ski runners for greater mobility. Soviet machine guns, such as the 12.7 mm, were tested under extreme cold conditions by US troops in Alaska. For 10 days the weapons were not cleaned but performed well for the entire period.

The Soviets have a great deal of experience in the use of field and antiarmor artillery under adverse weather conditions. Specific provisions and procedures for winter employment of cannon artillery include--

- Using glycerin-alcohol mixtures in the recoil mechanisms.
- Firing the first few rounds with reduced charges for gradual warm-up.
- Using a combination of large and small spades for snow or frozen ground.

Antiaircraft guns have special provisions for cold weather operations, including electrically powered hand-bar heaters and floor pads. These are necessary to obtain maximum performance from the operator of radar and electronic fire control equipment. The computerized antiaircraft fire-control director located inside the turret can operate at -40 degrees Celsius, as can most other antiaircraft fire-control systems.

Naval Force Operations

The adverse weather effects on Soviet naval forces are similar to those on US personnel as discussed in Chapter 1. Naval operations conducted during day, night, and adverse weather are similar since naval warfare is fought beyond the horizon.

Air Force Operations

Soviet aircraft are being improved to make them more capable in adverse weather conditions (see Appendix G). Use of Soviet helicopter assault forces allows greater flexibility in operational planning. These forces also train under adverse weather conditions.

Special Purpose Forces Operations

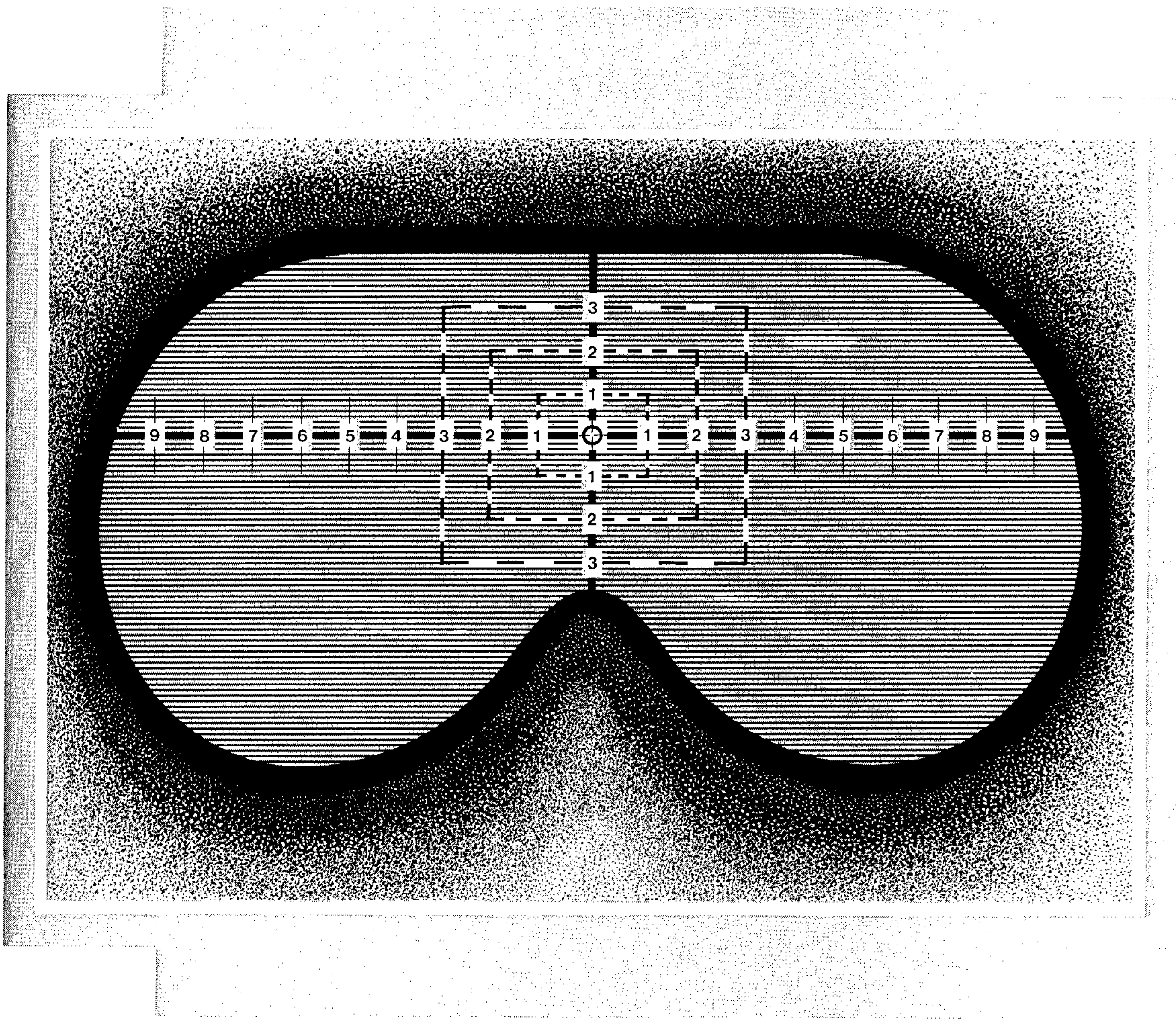
Soviet special purpose forces are equipped and trained to conduct operations in adverse weather. The effects of adverse weather on personnel as discussed in Chapter 1 apply equally to Soviet special purpose forces. The fact that most special operations are conducted clandestinely, however, enhances many benefits of adverse weather operations.

PART TWO

COMBAT OPERATIONS

Weather, terrain, and the day-night cycle constitute the basic setting for all military operations. These physical conditions significantly affect the movement, employment, and protection of units in campaigns and battles. Commanders must understand the operational and tactical implications of the physical environment as well as its effects on their soldiers, equipment, and weapons. The danger, destruction, and confusion of combat; the alteration of the terrain by weapons and obstacles; and the inevitable occurrence of the unexpected contribute substantially to an atmosphere in which things that were simply accomplished in daylight or fair weather become difficult.

Part Two of this manual discusses the various aspects of ground, maritime, air, and special combat operations conducted at night or during adverse weather. Successful joint combat operations under adverse conditions or during periods of limited visibility require thorough planning and an understanding of the environmental effects on all combat operations.



CHAPTER 3.

GROUND OPERATIONS

Increased mobility of ground forces and rapidly developing technology enhance capabilities to maneuver and engage the enemy at night and in adverse weather. Armies now have improved potential to fight in the daylight, at night, and during limited visibility caused by adverse weather. Combat operations at night or during adverse weather exploit the technological advantage of our forces to achieve surprise to avoid heavy losses which might occur in daylight operations over the same terrain. Successful operations under these conditions require thorough planning. Simple schemes of maneuver should be rehearsed and then executed aggressively. Operations of all units must be coordinated combined arms actions. In most cases commanders at both operational and tactical levels must coordinate intelligence, maneuver, fire support, engineer support, air defense, combat service support, and command and control. This chapter covers the effects of night and adverse weather on these functions of ground combat operations and the disadvantages and advantages of combat operations during adverse weather.

NIGHT

Night operations require detailed planning, close coordination within combined arms, and trained, disciplined troops.

Intelligence

Obtaining useful intelligence before initiating operations is a vital task. Information on the enemy and the terrain become more important at night and during reduced visibility as individual detection distances decrease and reaction times increase. Planners must use all available intelligence and electronic warfare (IEW) resources to accurately identify and locate targets, to avoid terrain difficulties, and to prevent surprise by the enemy.

Planning is crucial to the success of IEW operations. Their effectiveness depends on the degree to which they are integrated with the commander's scheme of fire and maneuver. Full integration is best achieved by systematic planning and full understanding of employment factors. Chapter 1 discusses the effects of night and adverse weather on radio communications and radar systems capabilities.

Maneuver

Maneuver requires strict coordination and speed, well-trained commanders and troops, logistically ready units, and light, noise, and communications disciplines. The problems of meeting these requirements are compounded during combat, since combat is a dynamic activity requiring moves and countermoves against a thinking enemy.

The focus of night offensive operations is on gaining or retaining the initiative. A night maneuver can concentrate forces at a critical point to more easily achieve surprise and gain physical momentum for later attacks.

Although night-vision technology makes nighttime land navigation easier, problems with terrain recognition at night make maneuver more difficult. Maneuver plans should still key on major terrain features such as roads, dominant hills, and unusual terrain formations. For exact position locations, artillery and target-acquisition systems rely on the position and azimuth determining system (PADS). Some systems are configured to use such devices as the modular azimuth position system and the global positioning system (GPS) (see Appendix I for details). When fielded, these devices will make land navigation at night less difficult.

Reliance on electronic sensors and NVDs for detection or observation is more critical at night. Because of the range and field of view of these sensors and observation devices, freedom of maneuver, deception operations, infiltration of positions, or unobserved emplacement of obstacles may be more successful at night.

Image intensifiers and thermal viewing devices make identification at close range easier, but long-range identification remains difficult and time consuming. In particular, image intensifier and first-generation IR NVDs have limited ranges. Units equipped with thermal sights have an advantage over those equipped with optical sights since thermal sights generally can view twice as far and are not limited by thick cloud cover.

Night helicopter operations require caution and more elaborate control measures. The capabilities of current NVDs may limit helicopter assets and slow air speeds. Target detection and engagement become more difficult, and aircraft turnaround time increases. In addition, because night navigation is more difficult, landing tasks require more time to perform and larger landing and pick-up zones. Many NVDs are blinded by strong light sources such as explosions and flares, causing temporary loss of sight to the user. Formation flight is more difficult and formations more dispersed. Pathfinder support may be required to provide the guidance and control necessary for safe and efficient operations.

Fire Support

Fire support coordination measures should follow readily identifiable terrain. Coordination of fires may take longer because accurate location and identification of friendly forces at night require greater time and effort. In the offense, permissive measures should be established well in front of friendly forces; restrictive measures should be used minimally to provide safety required, yet not complicate clearing fires at night. In the defense, permissive fire support coordination measures should be established as close to friendly troops as possible.

Supporting night combat with artillery, mortars, tactical aircraft, or naval gunfire requires the ability to detect the target and coordinate the attack. Generally, the techniques of employing supporting fires are not different from day operations except for certain critical considerations:

- If using illumination and smoke could be critical to the success of an operation, the planner must know the specific area and purpose for which the commander wishes to use them. Smoke should be planned to degrade the enemy's night vision. Conventional smoke (diesel fuel and hydrochlorethane) does not seriously degrade thermal devices but depends on weather conditions to be effective for long periods of time.
- Planners must place units in positions from which the units support the operation for as long as possible. Plans should include presurveyed alternate positions to shorten time-consuming moves as much as possible.
- Without the aid of night-capable systems, adjusting fires at night is difficult. Critical targets, such as final protective fires, should be adjusted during daylight if possible. Techniques such as meteorological data plus muzzle velocity (Met + VE) should be used to deliver first-round fire for effect on accurate target locations.
- Air Force tactical aircraft and Army attack helicopters may not be equipped with adequate night-vision equipment. In any case additional planning and coordination will be necessary to identify both friendly and enemy positions and mark targets for both conventional and precision guided munitions (PGMs) delivered by aircraft.
- Visibility and weather conditions affect the type of fire support provided and the type of PGMs available. Planners must understand the capabilities and limitations of all such systems to effectively employ them at night. See JCS Publication 3-09.1 for description of night-capable laser systems and procedures-

Engineer Support

The cover of darkness provides greater freedom from observation while repairing or improving roads and bridges or while breaching obstacles and minefields. This advantage is offset by the fact that night reduces crew efficiency and requires planning for longer times to complete operations. Darkness alone may not be sufficient to shield operations, such as river crossings or obstacle breaching, from enemy observation. In these instances, plans should include using smoke and/or deception to help protect troops.

Countermobility operations at night have the same advantages and disadvantages as mobility operations. The ability to emplace obstacles or minefields, particularly scatterable mines, unobserved by the enemy is a significant additional advantage.

Air Defense Artillery

Limitations on visual identification of aircraft reduce air defense capabilities. Correct identification of threat aircraft and weapons systems is necessary for short-range air defense. This is critical when short-range air defense (SHORAD) systems are used during limited visibility. Identification ensures timely engagement of enemy aircraft, conserves air defense assets, and reduces risk to friendly forces. Identification depends largely on a mix of procedural and complemental visual identification. Theater planners can assist with identification during periods of limited visibility by–

- Coordinating air and ground units.Establishing passage points and crossing times by aviation and ground maneuver units.
- Establishing both verbal and nonverbal recognition signals.

- Coordinating routes to and from the area of operations.
- Establishing air corridors and air control points.

Darkness severely limits the use of most optical-sight air-defense systems but does not affect the use of FLIR systems. However, pointing hand-held systems requires preliminary visual sighting which severely limits reaction time. Adverse weather, clouds, smoke, obscurants, and fog all degrade FLIR capabilities.

Combat Service Support

Principles of combat service support (CSS) during night operations are the same as those used during the day. The reduced capability to observe movement at night permits greater freedom of movement of resupply vehicles. Thus, conducting sustainment operations at night enhances the survivability of supply or transport convoys by reducing their vulnerability to observed fires.

Night CSS operations require detailed planning and coordination to ensure sustainment operations are conducted efficiently and unobserved. Detailed wheel and traffic plans are more critical at night to prevent congestion and traffic jams, which can cause significant delays. Planners must carefully consider the kinds of illumination that can be employed to mark wheel and track routes, identify resupply points, and perform maintenance repair and replacement operations. In addition, extra personnel or communications equipment may be required to provide security for forward supply operations and prepositioned supplies. Plans for responsive exchange and/or maintenance for NVDs, radars, and other equipment is also critical for night operations. As with combat tasks, night CSS tasks take longer to complete and planning for additional time to complete operations is critical to prevent stacking of vehicles in supply lines.

Also critical to sustainment operations is the ability for CSS units to navigate at night. The problems associated with night navigation and operations are amplified for CSS units not normally sufficiently equipped with NVDs. Providing CSS units with GPS (when fielded) will aid immensely in allowing critical supplies to reach the correct location quickly (see Appendix I for GPS description).

Command and Control

Successful night operations require detailed command and control procedures. Since combat is a dynamic activity requiring moves and countermoves against a thinking enemy, substantial challenges can arise with respect to maintaining situational awareness and unit integrity. In both defensive and offensive night operations, units react more slowly to unforeseen or altered situations and take longer to coordinate task reorganization.

Command and control problems are greater for attacking forces than for defending enemy forces. These problems can hinder reaction time for attacking forces to a changing situation or alter their operations.

Attacking forces may have difficulty determining the limits of obstacles and breaching them. They may easily be misled by extra lights and noises and are more subject to ambush. At night their units tend to separate--lead elements travel too fast, follow-on elements travel too slowly, and adjacent forces veer apart. During the final assault, they may lose momentum due to reduced traveling speeds.

Nighttime operations make forces more susceptible to command, control and communications countermeasures (C3CM) due to their increased dependence on radios and other electronic devices to maintain control or provide intelligence. As a result, ground forces can more readily create confusion through deception and disruption of enemy command, control, and communications. Since the reverse is also true, good operations security, firm discipline, and strong leadership are necessary to protect friendly command, control, and communications.

Defending forces are susceptible to infiltration and have more difficulty maintaining command, control, and coordination to counter breakthroughs and attacks. To increase security for night operations, commanders must--

- Use surveillance and aggressive reconnaissance.
- Set out security forces.
- Maintain operational security.
- Avoid operational patterns.
- Practice deception and deprive the threat commander of human intelligence by aggressive counterreconnaissance, surveillance, and target acquisition.

Because of the risks associated with night and adverse weather operations, operational security planners must use all appropriate measures to preserve security, including countersurveillance, electronic countermeasures (ECM), and deception.

Battlefield illumination for night operations can significantly enhance command and control. Illumination can be used to orient forces and coordinate actions as well as to acquire targets. Personnel at every level prepare and coordinate the illumination plan based on requests of supported units or as directed by higher authority. Coordination at all echelons of command ensures the integration of all means of battlefield illumination with fire support. The appropriate maneuver commander should be the approval authority for using illumination. Indirect fire illumination must be coordinated with adjacent units. Doing so will preclude accidental illumination of reconnaissance patrols, engineer activities, flank units, and so forth.

Types of Illumination

Hand-held, hand-thrown, rifle- or carbine-launched, and fixed devices may burn on the ground or may be suspended by parachute. The emplacement of fixed devices is reported to adjacent and higher headquarters, usually by graphics overlay. Coordination higher than battalion level is not normally necessary.

Some combat vehicle mounted lights can be used for either visible or near-IR illumination. While using direct, white searchlights is excellent for target illumination, the illumination source also becomes a target. Diffused or reflected white searchlight illumination is preferred to reduce self-targeting. For diffused illuminations, the searchlight beam is elevated slightly above ground. Lights scattered by atmospheric particles illuminate the area beneath, and to the flanks of, the beam. For reflected illumination, the beam is directed against low-lying clouds. Light reflected from, and diffused by, the clouds illuminates the area below. In general, active near-IR illumination is used like white searchlights, except that IR light is not effective for indirect illumination. Gated laser target illumination, or laser-enhanced viewing, is a means of semiactive illumination using a pulsed (gated) IR laser beam to illuminate a target for viewing by image intensifiers.

The commander of the supported unit controls the use of air-ground flares. The air liaison officer (ALO), enlisted terminal attack controller (ETAC), or airborne forward air controller (AFAC), effect surveillance and adjustment when tactical aircraft are used. The artillery liaison officer and/or fire-support officer (FSO) and the appropriate Army aviation officer do so when Army aircraft are used. Direct air-ground communications make accurate flare delivery easier.

Requests for Illumination

Table 3-1 shows information required by the fire support coordinator when requesting battlefield illumination.

Table 3-1. Information required to request illumination

	Search-lights	Artillery Mortar	Naval Gunfire	Aircraft Flares
Date required	X	X	X	X
Purpose	X	X		
Type of beam[1]	X			
Time and duration[2]	X	X	X	X
Location of target[3]	X	X	X	X
Description of target			X	X
Method of control[4]	X	X	X	X

[1]Focused or spread.
[2]For example," 3 minutes on call as of 2150."
[3]Marked map or grid reference and height of points or areas to be illuminated.
[4]For example, "At my command, continue when ready," and so forth.

ADVERSE WEATHER

Like night, weather affects all battlefield operating systems across the extended and integrated battlefield. Since its impact varies according to the type of ground forces, weather may dictate the most effective types of forces to employ. Weather also affects the kinds and levels of combat support and combat service support required to sustain the operation. Adverse weather creates many disadvantages to ground operations, but it also has some potential advantages. Figure 3-1 shows the disadvantages and advantages of adverse weather.

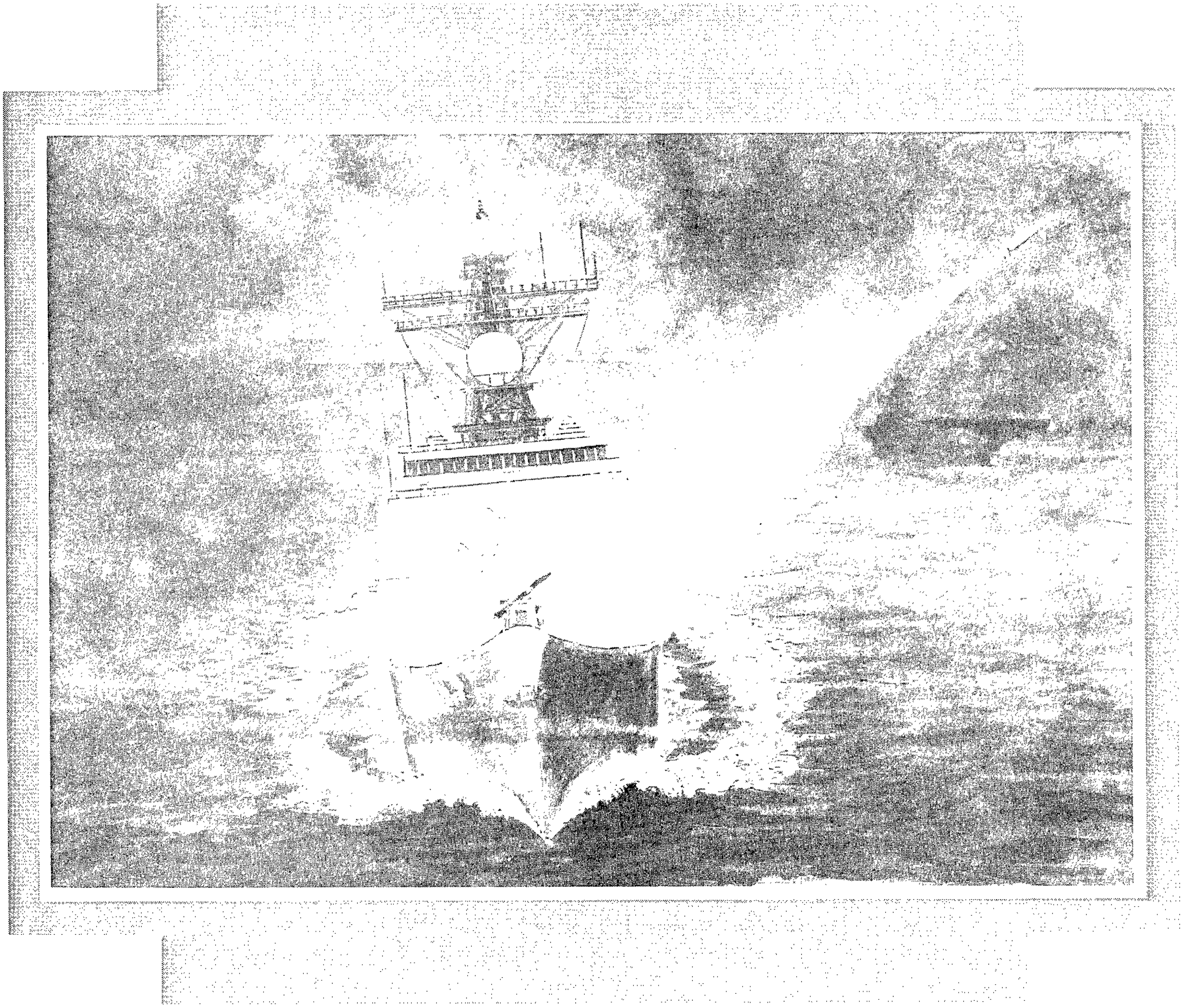
DISADVANTAGES

- Hinders visually acquiring a drop zone; may prohibit an airborne drop.
- Hampers reassembly of personnel and equipment during airborne operations.
- Degrades combat vehicle target acquisition, designation, ranging, and gunnery.
- Adversely affects soldiers physiologically (food, water, clothing, shelter, rest) and psychologically (fear, confidence, isolation).
- Increases susceptibility to nonbattle injury.
- Decreases mobility.
- Increases time to accomplish all tasks.
- Degrades visual target acquisition, tracking, and IR homing for air defense weapons.
- May cause surface-to-air missiles (SAMs) to leave ice exhaust trails in extreme cold, making the missiles more detectable.
- Degrades fire control and adjustments to field artillery fire.
- Degrades sound and flash ranging, ballistics, baroarming and barofusing, and fragmentation in field artillery operations.
- Affects soil-bearing strength, which may limit trafficability and engineer activities such as excavation, surveys, and beach and port operations.
- Degrades intelligence collection and dissemination systems' capabilities, thus decreasing reliability, increasing maintenance and interfering with equipment installation.
- Adversely affects communications and electronic equipment due to decreased circuit reliability, increased maintenance, decreased battery life, disruption of synchronized data transmissions, and variations in electromagnetic propagation.
- Delays and disrupts storing , handling, and transporting supplies, munitions and fuels.
- Damages storage facilities and storage materials.
- Affects available water supplies.
- Requires special storage practices for medical supplies.
- Changes concentration, dispersion, and persistence of NBC agents and smoke.
- Creates hot spots from NBC agent rainout and fallout.
- Reduces the life of chemical protective clothing.
- Impedes or curtails leaflet delivery and radio broadcasts.
- Reduces loudspeaker audibility during psychological operations.

ADVANTAGES

- Conceals friendly ground activity.
- Slows descent rate and softens the landing impact for airborne drops.
- Improves trafficability on frozen ground.
- Creates the same disadvantages for the enemy.
- Degrades enemy systems in predictable ways, which should be considered during planning.

Figure 3-1. Disadvantages and advantages of adverse weather



CHAPTER 4.

MARITIME AND AMPHIBIOUS OPERATIONS

In general, maritime and amphibious operations during night and adverse weather offer certain advantages. Air and surface platforms are less susceptible to optical and IR tracking systems. Low visibility offers concealment from visual surveillance and targeting. Heavy sea states and reduced visibility may, however, restrict carrier and amphibious air assets. Adverse weather conditions and reduced visibility will also affect landing craft ship-to-shore operations. Naval gunfire accuracy suffers if heavy sea states exceed gun stabilization limits. Conditions over land can also alter weather conditions over water drastically.

Planners need the greatest possible detail for maritime and amphibious operations, including the location of landing beaches, helicopter landing zones, and landing approaches; terrain features; enemy dispositions; and obstacles to movement. The plan of attack must be simple. It must define limited ground objectives and show easily recognizable approaches for seizing them. It must also consider all possible aspects of the operation, including tides, currents, beach composition, and angles since conditions may exists that could be disastrous during reduced visibility. Plans must also provide for the use of special directional and secure visual-signal apparatus and the means to minimize noise. Because of the special considerations involved and the detailed coordination required for such operations, planning must include extensive rehearsals.

NIGHT

The primary advantage of night maritime and amphibious operations is the visual concealment that it offers to both air and surface platforms. The advanced technology of the F-14 and F-18 air-to-air weapons systems should provide the added advantage of air superiority at night. In addition, both air and surface platforms can more readily observe enemy fires such as antiaircraft artillery, SAMs, and shore-firing batteries. Night is particularly advantageous to amphibious assaults and allows gunfire ships closer proximity to hostile shores.

Conversely, those same conditions which give advantages also restrict the conduct of active defense and CAS. Detailed protective measures, including specially organized defense forces and patrols, are frequently necessary.

Positive control of air and surface craft at night requires increased planning and coordination. At a given time, fewer maritime air assets will be available, and fewer aircraft will be able to attack a given target simultaneously. Darkness impairs ship-to-shore navigation for landing craft and may require terminal guidance support from ashore.

Ship-to-Shore Operations

An amphibious landing in reduced visibility is a ship-to-shore movement executed with at least the initial objectives captured during darkness or fog, rain, snow, or smoke. Landings under these conditions, when undertaken deliberately, are for the following purposes:

- To achieve tactical surprise.
- To eliminate or reduce the effectiveness of particular enemy defenses when no other tactic can do so.
- To provide secrecy in landing reconnaissance or raiding units.

Helicopter ship-to-shore movement during darkness and reduced visibility requires modified operating techniques and additional navigational and terminal control equipment, including--

- Screened identification lights.
- Luminious markings.
- Radar beacons (RBs).
- Radar reflectors.
- Portable radio direction finders.

To preserve tactical surprise, personnel must continue radio silence until the last possible moment before the landing of the first scheduled boat wave or until discovery of the force is reasonably certain. Using the radio is restricted, if possible, to vectoring boat waves only. Using sound equipment, screened colored lights for identification and signaling, IR signaling devices, Lucite wands, and flashlights with colored filters can assist in controlling the boat waves.

Lines of departure may be nearer the beaches at nighttime or during reduced visibility than in daylight. Transports, approach-lane marker ships, and primary control ships track boat waves by radar and, when necessary, vector them by voice radio. Radar-equipped boats may lead boat waves onto the beaches. Personnel with beach-marker lights come in each boat wave to mark the center of that beach. They may, when possible, precede the first wave ashore.

Advance Force Operations

Advance force operations should be conducted prior to D-Day by elements of the Amphibious Task Force. These elements include Navy sea, air, land teams (SEALs) and Landing Force reconnaissance Marines (force reconnaissance and battalion reconnaissance teams).

The SEALs and reconnaissance Marines of the advance force will participate in preparing the objective for the main assault by conducting such operations as reconnaissance, seizure of supporting positions, minesweeping, underwater demolitions and initial terminal guidance.

Using a wide variety of techniques, SEAL and reconnaissance Marines enter and depart the area of operations during darkness and adverse weather, avoiding detection.

Navigation and Control

Since landing a force at the proper place and at the proper time is even more important during night and reduced visibility, precise navigation is imperative. To ensure the correct positioning and guidance of all units, navigators must use all available means appropriate to the operating conditions.

The effective use of helicopters for the ship-to-shore movement depends upon the positioning of navigational aids and control personnel at the approaches and landings. Depending on the situation, inserting pathfinder teams by parachute or helicopter may allow them to install the necessary navigation devices to overcome the limitations of darkness.

Naval Gunfire

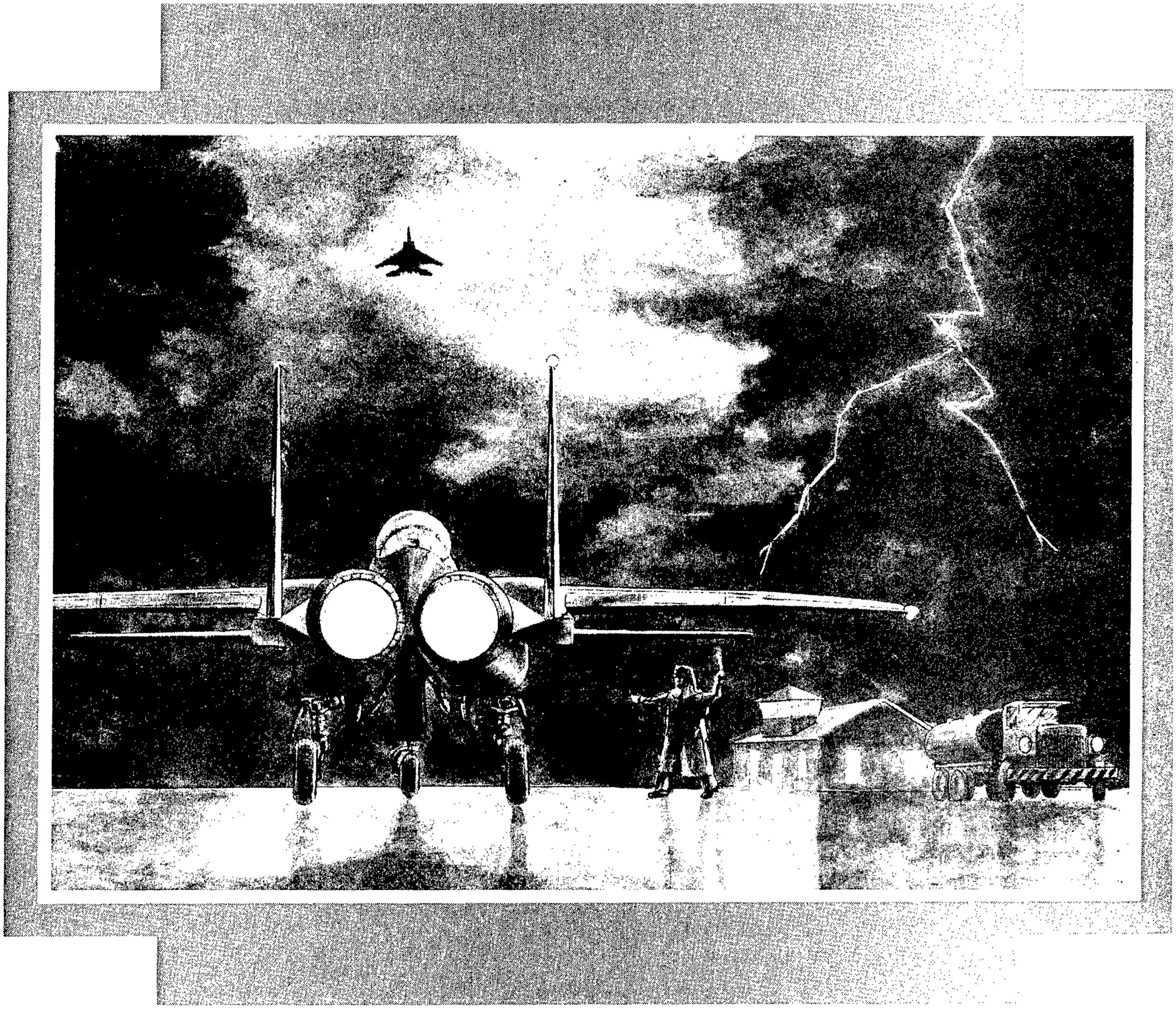
The preliminary bombardment must not divulge intended landing places and thereby sacrifice surprise. The primary purpose of naval gunfire before D-Day is to destroy forces and installations capable of interfering with air, naval, and landing force operations in the objective area. RBs and specially trained fire support ships and shore fire-control parties can guide naval gunfire for effective close support of the force ashore. Firing on the beaches or landing zones just before H-hour requires sight contact or a positive radar plot of the leading wave.

ADVERSE WEATHER

Because ships are enclosed, they limit the effects of weather on personnel. Weather conditions may, however, significantly degrade sensor and weapons systems by causing--

- Platform instability in rough seas.
- Immersion of deck-level equipment by seawater over the bow.
- Ice encrustation of antenna arrays and armaments.

Degradation of E-O and IR systems then leaves radar systems vulnerable to ECM. Otherwise, the advantages and disadvantages pertaining to night operations apply as well to adverse weather operations.



CHAPTER 5.

AIR OPERATIONS

Air operations on the joint battlefield can include Army, Air Force, Navy, and Marine Corps aircraft. This chapter describes the effects night and adverse weather have on types of air operations and addresses general planning considerations. It also discusses the capabilities of aircraft operating in the three levels of the air threat environment: low, medium, and high. This air threat environment is defined in terms of an assessment of the enemy's air defense capability against airborne friendly aircraft. Figure 5-1 describes these levels.

AIR THREAT ENVIRONMENT

LOW

A low air threat environment is one which permits combat operations and support to proceed without prohibitive interference. Associated tactics and techniques do not normally require extraordinary measures for preplanned or immediate support. Target engagement is enhanced by--

- Effective communications.
- Accurate target identification.
- Reattacks if applicable (limited only by aircraft time on station and ordnance on board).

In this threat level, the enemy has limited ability to effectively respond due to limited weapon systems and a poorly integrated air defense network. Weapon systems are usually few and typically include--

- Small arms.
- Optically aimed antiaircraft artillery up to 12.7 mm (.50 caliber equivalent).
- A limited number of man-portable SAMs.

MEDIUM

A medium air threat environment is one in which the specific aircraft performance and weapons systems capability allow acceptable exposure time to enemy air defenses. This air threat environment restricts the flexibility of tactics in the immediate target/objective area. The medium threat environment normally allows medium-altitude missions/attack deliveries with a low probability of engagement by enemy air defenses. Enemy weapon systems are in a moderately integrated air defense network, but they are few or poorly deployed. Weapon systems typically include--

- Low-threat systems.
- Limited radar and/or electro-optical acquisition capability at medium ranges.
- Early-generation surface-to-air missiles.
- Radar-directed antiaircraft artillery.
- Aircraft lacking look-down/shoot-down and/or all-weather capability.

HIGH

A high air threat environment is one created by an opposing force possessing air defense combat power including integrated fire control systems and EW capabilities, which would seriously diminish the ability of friendly forces to provide necessary air support. This air threat environment might preclude missions such as immediate CAS, as required radio communcation and coordination may not be possible. The high air threat environment may include but is not limited to--

- Low and medium threat systems.
- A command and control system.
- Advanced mobile and/or stationary SAMs.
- Early-warning radars.
- EW and electronic counter-countermeasures (ECCM).
- Integrated AAA fire control systems.
- Interceptor aircraft (look-down/shoot-down).
- Wartime reserve modes.
- Air-to-air capable helicopters.

Figure 5-1. Air threat environment

NIGHT

The ability of fighter/attack and other aircraft to perform air-support missions at night is critical to the success of joint operations. Subsequent to the joint force air component commander's (JFACC's) apportionment recommendation, the joint force commander establishes priorities of all tactical aircraft missions through his periodic apportionment decision.

The night capabilities of aircraft vary according to mission but are generally limited. In a low-threat environment, the capabilities are fairly good, but in a high-threat environment, they are limited (see Appendix E for equipment data).

Effects on Types of Operations

Fighter/Attack Aircraft

Air superiority fighters and reconnaissance aircraft are capable of performing defensive counterair and reconnaissance at night. While certain fighter bombers are capable of performing night offensive counterair against airfields and air interdiction against fixed targets, their numbers are currently very limited. New night navigation and targeting systems, such as low-altitude navigation and targeting infrared (LANTIRN), will increase the number of aircraft capable of attacking such fixed targets and should provide limited capability against moving targets, as well.

When flying CAS at night, fighter/attack aircraft are less vulnerable to all enemy optically sighted surface-to-air threats, particularly those not having NVDs. Darkness, however, also limits the use of fighter/attack aircraft. With limited visual identification capabilities, pilots find pinpoint target identification and accurate location of threat and friendly forces difficult. As the antiaircraft threats from SAMs, radar-guided antiaircraft artillery, and enemy aircraft intensifies, the ability to provide CAS at night decreases. As the threat intensity decreases, target acquisition during night CAS improves and fighter/attack aircraft have good night CAS capabilities for the low-threat scenario. CAS aircraft can more easily see and defeat low-threat weapons having muzzle flash and tracer or missile burn. However, maneuvers in response to threats at night or in adverse weather are more likely to cause spatial disorientation than similar maneuvers flown in daylight or clear weather conditions. As a general rule night CAS will be carried out by flights of two to four aircraft.

Airlift

Airlift operations include strategic and theater air-land and air-drop missions. The principal advisor to the Air Force component commander on the use of Air Force airlift forces is the Commander, Airlift Forces, who exercises operational control of theater-assigned forces and monitors and manages strategic airlift forces through the airlift control center.

Tactically qualified aircrews of MAC train extensively for night operations and conduct many operational missions at night. In the near term, limited capability to accomplish night strategic airlift operations requiring low-level (threat avoidance) flight profiles exists. Night combat conditions limit the enemy's ability to visually acquire aircraft. As a result, the enemy's inability to determine mission objectives, force size, and flight routes provides a tactical advantage to, and increases the survivability of, friendly airlift forces.

While night operations increase aircraft survivability, they also complicate mission planning and execution. En route navigation is more difficult due to the inability to clearly see terrain and cultural features. Terrain masking and avoidance of radar threats are more difficult because aircraft are unable to fly as low as during daylight hours. Acquisition of the objective area is especially difficult without some type of visual marking or high-moon illumination. While select C-130 and special operations forces are capable of performing airdrops to blind, unmarked drop zones, they depend upon adequate radar target identification, which planners must consider during planning and employment.

Special equipment, which is available on some aircraft, greatly enhances night operations.

Aircraft radar, inertial navigation systems, adverse weather aerial delivery system (AWADS), and station-keeping equipment (SKE) enable more accurate en route navigation and aerial delivery of people, supplies, and equipment (see Appendix E).

While some airlift aircraft have upgraded navigation systems, most have little or no defensive systems. Air Force component planners must be aware that as the threat level increases so does the requirement for defensive support measures, that is, ECM, suppression of enemy air defense, combat air patrol, and preparation of the objective area.

Strategic Bomber

Strategic Air Command (SAC) strategic bombers provide theater commanders a responsive long-range force capable of penetrating enemy territory to conduct a variety of air operations to support theater campaigns. The long-range, unrefueled, heavy payload, all-weather, day and night capabilities make long-range bombers especially effective in conducting the strategic air campaign. In addition, the emphasis on night training to ensure the crews are totally knowledgeable in night employment make the strategic bomber one of the most capable night and all weather aircraft.

The primary method of weapons delivery, when employing conventional gravity munitions, is by radar aiming augmented by visual cues. The pilots use visual cues from the FLIR, steerable TV, or NVGs to refine navigation and aiming for weapon delivery.

Search and Rescue (SAR) and Combat Search and Rescue (CSAR)

Resources dedicated specifically to SAR and combat search and rescue(CSAR) tasks consist of–

- Command, control, communications and intelligence personnel.
- Various fixed-wing and rotary-wing aircraft.
- Pararescue forces.
- Maintenance forces.

Other aerial and surface forces can quite often facilitate these tasks. Even though the rotary-wing aircraft are the primary recovery vehicles, fixed-wing aircraft provide necessary airborne command and control, search, airdrop, helicopter aerial refueling, and force protection capabilities. Pararescue or like forces provide the essential surface-to-air link with the mission objective which can be either isolated personnel or priority materiel.

MAC provides dedicated search, rescue, and recovery forces to support Air Force and National Aeronautics and Space Administration SAR and CSAR tasks. MAC trains these forces extensively for conducting night and adverse weather SAR operations and often employs them during peacetime missions. The aircrews use night-vision goggles (NVGs) with the aircraft's radar and defensive systems to enhance their night capability. Pararescue forces use NVGs to perform aircrew and surface tasks including surface search, objective contact, and administration of medical treatment (see Appendix E for systems data).

Air Refueling

Newer systems on tankers and receivers make rendezvous easier. Therefore, refueling operations, whether at night or during the day, can proceed without adverse effect pending no adverse weather.

Planning Considerations

The planning considerations for air operations at night vary significantly from those for adverse weather operations. For example, the time span for night operations can be clearly defined for a given day. Based on latitude and the time of the year, the night window can vary from 0 to 24 hours.

Night air support planning and coordinating responsibilities for ground commanders are extensive. They should consider such things as–

- The location of all friendly forces.
- Target and aircraft identification.
- Availability of mortars or artillery for target illumination and suppression of enemy air defense.
- E-O and laser capability of attack aircraft.
- Laser designation capability of the tactical air control party and fire support team.

- Laser designation capability of the tactical air control party and fire support team.
- Aircraft support for illumination with aircraft flares.
- Friendly and enemy air defense systems.
- Deconfliction of airspace control areas and other procedural control measures used to prevent fratricide, for direct and indirect fire support.

Appropriate ground and air agencies must coordinate the plan as early as possible. Ground commanders should be aware that requests for night CAS may strongly affect many other aspects of air operations including day CAS. Aircraft may need to be configured differently for day and night CAS missions.

Target Location

The first priority in night attack operations is accurately identifying the target location using the best available means. These means may include flares, artillery, laser designators, and radar. Under certain conditions it may even be possible to use smoke to mark a target. Accurate target identification and location improves the probability for a successful first-pass target attack. The second priority is accurately identifying friendly force locations. Once supporting aircraft have identified the target and friendly positions, they may then reference enemy air defense locations from the target location.

When aircrews have become familiar with the target area and terrain features, they may use tactics and procedures similar to those used during daytime. Refer to Appendix E for capabilities of fighter/attack aircraft night-targeting systems.

Ground commanders should attempt to first rely on organic assets to mark and/or illuminate a target at night. The ALO, ETAC, or AFAC may also request tactical aircraft illumination support if illumination from ground assets is not available or is not adequate. Following are several means for target area location and illumination:

Flares. A flare-ship or AFAC aircraft can release long-burning illumination markers that will burn on the ground for up to 45 minutes.

Artillery, mortars, or naval gunfire may also fire illumination, white phosphorous, or other rounds to impact on the ground and mark a location. Fires can also be started on the ground by other means. These types of marks serve as target markers or common references for attack aircraft or as distance and direction references to another location.

Airborne flares from an AFAC, fighter, attack, flare-ship aircraft, artillery, mortar, or naval gunfire can effectively illuminate a designated area. Airborne flares are generally preferred because they illuminate best. Higher threat environments may preclude delivery of flares by airborne platforms, however, and artillery, mortars, or naval gunfire may be the required delivery means. Height-of-flare illumination and proximity to target areas are important factors for planning effective lighting.

Weather is also a consideration when using flares at night. Of the weather factors, wind is the most significant. Planners should consider flare burn time, delivery altitude, and wind drift for optimum target illumination to coincide with the time of weapons delivery. When visibility is low, airborne flares used under a cloud deck may create a milk-bowl effect, making it more difficult for an aircraft to find the target. In addition, the illumination may highlight the aircraft against the clouds on their final run-in. Under such conditions, long-burning illumination markers on the ground (previously discussed) may be the better choice to mark the target.

Target self-identification. The muzzle flash illumination from enemy ground fire, field artillery/mortars, antiaircraft artillery, or SAM firings may also identify a target area.

Laser designators. Laser designating devices can also enhance night target acquisition. Some attack aircraft may be, and all AC-130 gunships are, equipped with laser spot trackers (LSTs), which can acquire targets without using conventional illumination devices. Ground unit; ALO, ETAC, and AFAC; and aircrew coordination are paramount during laser operations. Appendix C discusses the use of LSTs for night CAS.

Radar. Radar-equipped aircraft can use radar-significant terrain points, radar reflectors, or portable RBs as radar returns in the target area. Doing so provides useful reference information for blind-bombing or beacon-bombing fire support. During night radar bombing, the aircrew will not have visual contact with the target or friendly forces. Because of the inherent risk to friendly ground troops, only the ground commander can authorize radar bombing during CAS operations.

Surface features provide radar signatures of varying value. Additional radar cues can be created by making small radar reflectors optimized for the particular airborne radar. These are simple to make, require no batteries, and can be sited so as to reduce tampering and hazards to friendly forces. Several reflectors at a site can improve radar return and, placed in a distinct array, create a unique signature. Three-sided reflectors are highly directional, and four-sided reflectors are even more so.

RB bombing uses the receiving capability of the aircraft radars in some fighter/attack aircraft. RBs provide a discreet, coded radar signature that is used as an offset aiming cue for radar bombing. They can also provide references for friendly positions. ALOs, ETACs, and AFACs must confirm that RB bombing aircraft are using the offset delivery mode to preclude bombing the beacons.

The Marine Corps air-support radar team (ASRT) has a transportable ground-directed bombing system that can provide precision radar tracking and positioning of aircraft at night and during all weather and visibility conditions. A limitation of ASRT however, is that it can provide precision guidance to only one aircraft at a time. The ASRT has the AN/TPB-1D radar bomb-directing set which uses--

- Surveyed position of the radar on the ground.
- Location of the target, wind profile, ejection velocity, and ballistics of the munitions being dropped.
- Radar-derived aircraft position and speed to guide the aircraft to the proper release point.

Electronic long-range navigation (LORAN) bombing is highly accurate if target information includes precise coordinates. For example, aircraft equipped with LORAN capability can attack known enemy locations in a LORAN operational area such as Korea.

Friendly Force Location

Whenever possible, friendly positions should be marked so as to comply with recommend risk-estimate distances. In addition to flares and RBs, other marks used to identify friendly positions include tracers, strobe lights, and search lights. Combinations of two or more of these marks improve chances of acquisition and security of the signal.

> **CAUTION**
> Using friendly marks requires careful consideration, since the precise location of friendly forces may be compromised.

Flares, such as trip flares and 40-mm illuminating grenades, fired in the air are effective marks but are usually also visible to the enemy.

Strobe lights are often excellent aids for night marking. They are commonly used with blue or IR filters and can be made directional using any opaque tube. Ground strobe lighting must, however, be used with caution. Pilots must have at least generally identified friendly positions to avoid mistaking strobe lights for enemy muzzle flashes.

Bright directional lights are one of the best marks for overcast conditions. They are highly directional and can easily be covered with a colored filter. Vehicle lights are also useful nighttime marks, however, covering unnecessary lights may be needed for security. Any light source that can be readily covered and uncovered can be distinctive and can be used for coded signaling.

ADVERSE WEATHER

The operational weather window is never totally predictable, nor is it easily defined. Weather conditions can create a worst-case situation in which all available air-support aircraft would be grounded. On the other hand, weather conditions may only affect a limited number of weapons systems for a limited period of time. Since combat systems are affected predictably, using tactical decision aids to identify limitations of predicted weather is an important planning tool. But since prediction is never perfect, the weather window can have the most insidious and dramatic effect on shaping the battlefield.

Effects on Types of Operations

Fighter/Attack Aircraft

Fighter/attack aircraft operations are essential to conducting an effective theater campaign. Because fighter/attack aircraft cannot operate under certain adverse weather conditions, commanders must keep informed of the battlefield weather situation.

Adverse weather impacts greatly on the ability to obtain current information on threat damage assessment and enemy movements. Any significant cloud cover in the target area will limit visual imagery, and as a result, limit reconnaissance operations. When clouds or visibility is a factor, platforms with radar capability could be required.

Fighter/attack aircraft have varying capabilities to provide effective air support in adverse weather. Weather conditions under which fighter/attack aircraft can provide support depend on such factors as--

- Air threat environment
- Mission criticality.
- Theater.
- Aircraft type.
- Aircrew experience.
- Ordnance loads.
- Airfield recovery criteria.

As long as battlefield weather permits ingress and egress of the target area and exceeds target attack minimums, fighter/attack aircraft can perform visual air interdiction and CAS. If ceilings and visibility render visual targeting systems ineffective, then aircraft must use such nonvisual systems as inertial navigation, radar, LORAN, ASRT systems, and beacon bombing. Radar bombing requires fixed targets or fixed radar-significant offsets and aim points. As discussed under night operations, radar-equipped aircraft can use radar-significant terrain points, radar reflectors, or RBs as radar returns in the target area.

Adverse weather degrades enemy IR and optical threats to fighter/attack aircraft but has less effect on radar-directed antiaircraft artillery (AAA) and SAMs. Therefore, suppression of enemy air defenses will most likely be necessary against radar systems.

Airlift

Airlift operations can occur during periods of reduced ceilings and visibility. They can also occur during a wide range of wind conditions. Surface winds can, however, be a limiting factor, especially on airdrop operations. Special equipment, such as AWADS and SKE, on some aircraft allows successful completion of airdrop operations during adverse weather. Aircrews must train to use this special equipment and the necessary tactics.

Severe weather such as thunderstorms, heavy icing, and ground fog hamper airlift missions most. If airlift missions operate in a high-threat environment, adverse weather can hinder friendly visual acquisition of enemy AAA and SAM firings. This could be critical since Air Force airlift aircraft have limited defensive capability. Finally, adverse weather operations place an extra demand on mission requirements, planning time, and logistical support.

Strategic Bomber

Few weather phenomena limit the ability of strategic bombers to attack assigned targets. Low ceilings and poor visibility may force the aircraft to fly at slightly higher altitudes during ingress, weapons delivery, and egress if the crew is using visual tactics. Heavy rain may affect the terrain-following/terrain-avoidance (TF/TA) radar of these aircraft, requiring them to fly at higher altitudes. Employment tactics will be determined by the threat, the desired level of damage, and munitions. Low altitude generally provides increased survivability and bombing accuracy while high altitude provides more range and flexibility. Severe weather, such as hail, heavy icing, or intense thunderstorms can prohibit attack by aircraft.

Adverse weather can sometimes help bombers by degrading the optically aimed, and sometimes radar aimed, enemy defenses. However, if adverse weather affects the ability of support forces to provide suppression of enemy air defenses in highly defended areas, bombers may not be able to effectively attack targets. When planning attacks, planners must evaluate the ability and requirement of the composite force to operate in adverse weather.

Search and Rescue and Combat Search and Rescue

Severely reduced visibility caused by fog, haze, and precipitation is the primary limiting factor for SAR operations during daylight and darkness. These conditions especially limit the effectiveness of NVGs.

SAR operations are possible in conditions with reduced ceilings as long as inflight visibility remains above the aircraft's operating limitations. The use of specialized night and adverse weather equipment on some aircraft can allow some CSAR forces to conduct operations in otherwise prohibitive threat environments.

Specific equipment which can offset the effects night and adverse weather conditions will have on SAR operations fall in two categories: those for aerial operations and those for interacting surface forces. Specialized aerial operations equipment can include–

- Precision navigation equipment.
- TF/TA radar.
- FLIR.
- Personnel locator systems.
- Direction finding avionics.
- Weather radar systems.
- Defensive countermeasure systems.
- Instrument lighting compatible with NVGs.
- NVGs.

However, only certain special operations aircraft have all these capabilities. Specialized equipment for interacting surface forces includes--

- Night-vision and sighting devices, miniature IR lighting equipment.
- Ruggedized, man-portable direction finding systems and night camouflage clothing.

Air Refueling

Air refueling is a critical element of an air operation and adverse weather severely impairs ability to refuel. During operational planning and mission execution, weather impacts and alternatives must be identified. SAC tankers have upgraded a number of systems which minimize the visual requirement needed to conduct refueling operations. These systems are most critical when the airspace environment does not allow the use of ground controllers to provide vectoring for rendezvous.

Integration of inertial navigation systems (INS) on SAC KC-135s and KC-10s has improved navigational accuracies. It enables tanker crews to transit long distances to arrive at coordinated rendezvous points at the precise time required. Air-to-air tactical navigation and aircraft radar aid in joining refueling elements. In select situations, crews use NVGs to enhance the their ability to refuel successfully under minimum lighting.

Planning Considerations

Prelaunch

All outdoor maintenance and uploading may take longer, or even cease, during periods of extremely low or high temperatures, heavy precipitation, thunderstorms, lightning, strong winds, and restricted visibility. Aircraft turn-around times may increase. During freezing rain and snow, personnel may need additional time to deice the aircraft and to clear runways and taxiways. Consequently, such conditions may reduce sortie generation rates and the number of aircraft available to cover the full range of support requirements.

Effective mission planning is paramount. When inversions are present over water, planners should select altitudes which allow aircraft to penetrate the coastline undetected. Furthermore, they should select the most effective combination of aircraft weapons. For example, if precision bombing is necessary to limit collateral damage, an E-O weapon might be used (see Appendix A). However, if dry haze limits the visibility over the target, a laser munition and IR target-acquisition system should be used rather than a television (TV) weapon and target-acquisition system.

Launch

Depending on the mission priority in combat situations, aircraft may launch regardless of adverse weather. However, adverse weather during take off can limit aircraft performance, that is, lift and control, or degrade flight safety. The following can affect launch operations:

- Temperature.
- Density altitude.
- Winds (crosswinds, gusts, low-level wind shear).
- Ceilings.
- Visibility.
- Precipitation.
- Obscurants.
- Thunderstorms (hail and lightning).
- Turbulence.

En Route Operations

Adverse weather encountered along the planned route or in the refueling area can also affect the mission. Changes to the flight profile--altitude, ground speed, route--due to weather affect mission timing and may increase threat risks. Timing is especially critical in joint and integrated operations. Changes in flight profile can also adversely affect fuel consumption, range, time on station, and time on target. Nap-of-the-earth flying can be risky during poor visibility.

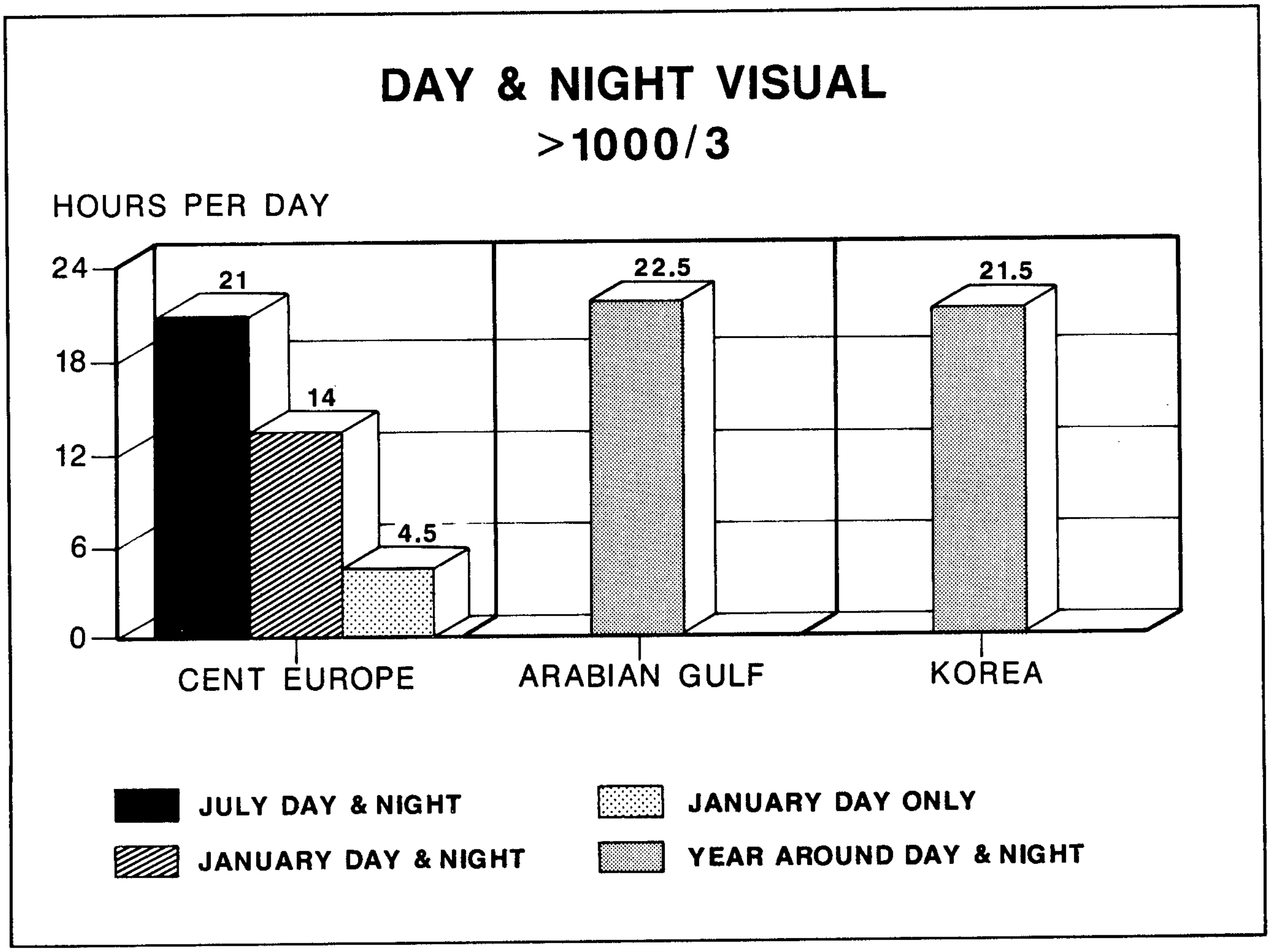
Mission Execution

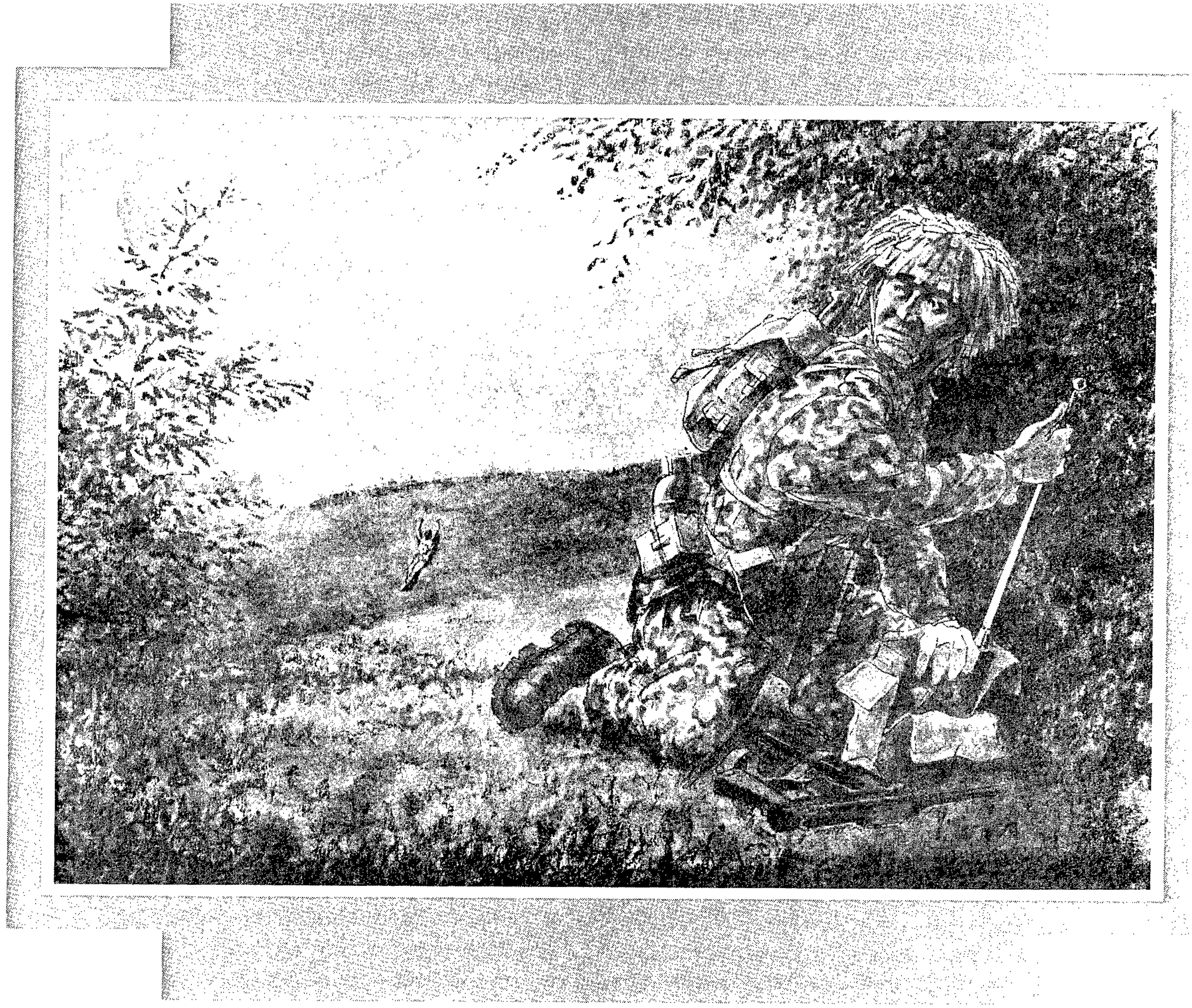
Weather can affect the target and drop zone acquisition cycle (detect, orient, recognize, and identify). Encountering adverse weather during any of these phases can hinder mission accomplishment. However, using the appropriate munition, delivery tactics, and PGM performance can minimize weather effects. Surface weather conditions temperatures of the target and background, air temperature, precipitation, wind speed, and dew at the target can also affect delivery of munitions or cargo.

Recovery

Adverse weather conditions can prevent recovery at the planned destination or home station and cause aircraft to divert to an alternate station. If aircraft are seriously damaged, even marginal weather could cause diversion to alternate locations. However, the alternate base may not be capable of handling the needs of the aircraft, which could also hinder recovery as well as future missions. Ceilings, visibility, winds, low-level wind shear, precipitation, thunderstorms, lightning, hail, icing, turbulence, and poor runway and flight-deck conditions all may affect recovery.

Table 5. Typical weather conditions





CHAPTER 6.

SPECIAL OPERATIONS

Special operations are actions conducted by specially organized, trained, and equipped, military and paramilitary forces to achieve military, political, economic, or psychological objectives by nonconventional military means in hostile, denied, or politically sensitive areas. These operations are conducted in peace, conflict, and war. Often politico-military, they may be conducted independently of, or in coordination with, other military operations and may either support or be supported by conventional forces. Since they are frequently high-risk operations, they may be clandestine, covert, or low visibility and may not be noticed nationally.

Special operations usually differ from conventional operations in operational techniques, mode of employment, distance from friendly support, and dependence upon operational intelligence and indigenous assets. This chapter deals only with that portion of special operations concerning the combat and intelligence-gathering function during UW, direct-action, special reconnaissance, and counterterrorism missions in enemy-controlled or politically sensitive territory. It also deals with that portion of special operations conducted under joint command and control.

Because fewer forces conduct these special operations, successful execution requires secrecy and stealth. Special operations forces (SOF) make maximum use of night and adverse weather conditions to avoid detection by hostile forces and to attack enemy positions.

Special operations may be direct-action operations. Similarly, conventional forces may support SOF in any of these missions that fall within the conventional unit's area of interest.

NIGHT

Scheduling key events of a mission at night allows SOF to maintain operational security and achieve mission goals. Planners should exploit the advantages of night operations while considering the requirements for special operations missions.

As SOF conduct missions in enemy-controlled territory, they must conceal their presence and location from the enemy. The reduced visibility conceals the approach and withdrawal of air and naval craft supporting the infiltration and exfiltration of SOF and enhances their ability to move undetected. Night also conceals the size and composition of SOF units. It permits SOF units to break off contact and withdraw if detected or if overt action occurs at the target area.

Night special operations exploit the relaxed readiness and reduced alertness of enemy defense forces protecting infiltration and exfiltration points and high-value targets. Defense forces are usually much less active at night, minimizing accidental sighting of SOF. Frequently, the enemy reduces its guard force at night, and inevitably, troop alertness decreases as a result of circadian rhythms or fatigue. Darkness disrupts command and control of enemy ground units attempting to counterattack SOF units. Because of the type of training and relatively small size of SOF units, night does not significantly degrade their tactical command and control capability.

Preventing enemy detection of SOF units requires pinpoint accuracy for navigating to infiltration and exfiltration points and for moving to the target. Lack of visual references during darkness increases the difficulty of SOF navigation. However, technological advances in navigation systems, such as the GPS, allow SOF to be less dependent upon visual terrain references. This is particularly true for boat infiltrations launched from over the visible horizon. Similarly, rendezvous between SOF units and supporting exfiltration platforms is extremely difficult. In most cases, the required navigation parameters can be met only by using electronic navigational aids.

Darkness reduces the ability of SOF to accurately coordinate delivery of supporting fire by tactical aircraft or naval weapons. It also reduces the accuracy and completeness of intelligence obtainable by SOF. Use of NVDs will not fully compensate for this disadvantage. Overall, the need for darkness to provide concealment and achieve tactical surprise significantly constrains operational planning.

Miscalculating transit times or the amount of time required to conduct infiltration, exfiltration, or actions at the objective will extend the mission into daylight hours. This may compromise the unit's presence and may cause the mission to fail. Planners must develop realistic time lines for the mission as well as contingency plans when key events cannot be completed during darkness.

Planners must schedule movement based on the close analyses of terrain, environmental factors, and enemy order of battle, as well as the difficulty of night clandestine movement. As a rule of thumb, underestimating the distance a unit can move in a single night is better than overestimating that distance.

Natural night illumination by the moon and stars may reveal the location of SOF to hostile observation. Planners must consider the moon phase, the time of moon rise and set, the aspect of the moon, and the impact of any cloud cover or fog.

SOF units must have access to position and navigation information. Such access is critical to SOF rendezvous with supporting assets.

Night conditions and the need for secrecy hinder or keep SOF units from establishing impromptu visual communications with supporting assets. Planners must ensure that radio communications and clandestine signalling devices are compatible. SOF units and units supporting the operation must have the required equipment.

Because some SOF units must be stationary to receive and transmit HF communications, night communications are preferred to allow concealment of antenna systems and operators who may need to remain in one location for up to one hour to receive and transmit a message.

ADVERSE WEATHER

In general, adverse weather enhances the effects of surprise, since the enemy tends to take shelter and become less alert. However, long-term exposure to weather also fatigues and degrades the capability of SOF. The following are adverse weather conditions and the impact they have on special operations--

- Precipitation, fog, sand, and dust storms decrease visibility.
- Precipitation, temperature extremes, or both decrease physical capabilities of SOF personnel and enemy forces.
- Rough seas or high winds affect infiltration and exfiltration of SOF units.

Adverse weather provides SOF the same advantages as night: it provides concealment, enhances tactical surprise, and reduces the enemy's readiness and capabilities. Each type of adverse weather offers unique operational advantages. Within limits of operational capability or survivability, the more adverse the weather, the more conducive it is to special operations. Precipitation provides conditions conducive for concealment and surprise. Light-to-moderate precipitation offers particular advantages for direct-action missions. Precipitation can also attenuate radar returns, enhancing the ability of SOF infiltration and exfiltration aircraft and naval craft to avoid detection. Similarly, high seas mask the radar return of naval craft supporting SOFs off coastlines protected with sea-search radar.

Adverse weather generally provides the same disadvantages as night operations. It makes navigation more difficult, impairs control of supporting arms, decreases ability to gather intelligence, and constrains planning. Each type of adverse weather has some unique disadvantages for special operations. The disadvantages common to conventional operations are magnified for special operations because SOF missions are normally conducted by small, unsupported units in enemy-controlled territory.

Planning should exploit the opportunities offered by adverse weather while including the unique requirements for successful special operations in such weather. Planners, however, must not underestimate the unexpected harmful effects of adverse weather on special operations or overestimate the ability of SOF to operate in extremely adverse weather.

If SOF units are to sustain operational effectiveness, planners must identify means of providing sufficient shelter from the elements. They must consider logistics in extreme temperature climates. They must not overload personnel with life-sustainment items, such as water, food, and cooking fuel, or underestimate the need for these items. Any sustained operation will require resupply of essential items.

APPENDIX A.

ELECTROMAGNETIC CONSIDERATIONS

Equipment / System	Human Eye / LLLTV (.4 -.74 μm)	Near IR (.5 - 1.1 μm)	IR (3 - 14 μm)	Radar (1mm - 10cm)
AN/PVS-2b	Rifle Sight			
AN/PVS-4	Rifle Sight			
AN/PVS-5/5a	NVG			
AN/PVS-7b	NVG			
AN/VVS-2	Drivers NVS			
AN/AVS-6	Aviator NVG			
AN/TVS-5	Crew NVS			
AN/TVS-4	Tripod/Vehicle			
AN/TAS-4 (Tow)			Thermal	
AN/TAS-5 (Dragon)			Thermal	
AN/GVS-5		Laser		
AN/PAS-7			Thermal NOD	
AN/VSG-2 TIS		Laser	Thermal	
AH-64 TADS		Laser	Thermal	
AH-64 PNVS			Thermal	
OH-58D MMS	NVG	Laser	Thermal	
AH-1 C-NITE		Laser	Thermal	
AN/PPS-4				GSR
AN/PPS-5				GSR
AN/PPS-15(V)1				GSR

Figure A-1 Equipment Data

Aircraft / Equipment	Human Eye / LLLTV (.4 - .74 μm)	Near IR (.5 - 1.1 μm)	IR (3 - 14 μm)	Radar (1mm - 10cm)
A-6E		Laser	FLIR	Radar
A-7		LST	FLIR (limited)	Radar
AV-8B (Night Attack)	NVG	Laser	FLIR	
A/OA-10		LST		
F-15E		Laser	FLIR	Radar
F-16 (LANTIRN)		Laser	FLIR	Radar
F/A-18	NVG		FLIR	Radar
F-111 (Pave Tack)	TVO	Laser	FLIR	Radar
F-117A	CLASSIFIED			
OV-10D (Marine)	NVG	Laser	FLIR	
AH-64	NVG	Laser	FLIR	
AH-1	NVG	Laser	FLIR	
OH-58D	TVO NVG	Laser	FLIR	
OH-6	NVG			
AC-130	TVO	Laser	IR Detector	Radar
HC-130	NVG			Radar
MC-130	NVG		FLIR	Radar
C-130 (AWADS)	NVG (limited)			Radar
MH-47	NVG			
MH-53	NVG		FLIR	Radar
MH-60	NVG			Radar
B-52	TVO NVG		FLIR	Radar
B-1B				Radar
AGM-65		Laser	IR	
GBU 10/12/15/24		Laser	IR (15)	

Figure A-2 Aircraft Data

Environment \ Wavebands	Human Eye / Low Light TV (.4 - .74 µm)	Near IR (.5 - 1.1 µm)	IR (3 - 14 µm)	Radar (1mm - 10cm)
Drizzle	◑	◑	○	○
Light Rain	◑	◑	○	○
Moderate Rain	◕	◕	◑	◑
Heavy Rain	●	●	●	◑
Light Snow	◑	◑	○	○
Moderate Snow	◕	◕	◑	○
Heavy Snow	●	●	●	◑
Sleet	◑	◑	◑	○
Ice Crystals	◑	◑	◑	○
Hail	◕	◕	◕	◑
Fog	◕	◕	◕	○
High Absolute Humidity	○	○	◑	◑
Dry Haze	◑	◑	○	○
Wet Haze	◕	◕	◑	○
Smoke	◕	◑	◑	○
Blowing Dust	◕	◕	◑	○
Blowing Sand	◕	◕	◑	○

● Total Degradation

◕ Severe Degradation

◑ Some Degradation: degree will vary according to distance between target and sensor.

○ No Degradation

Figure A-3 Environmental Impact Data

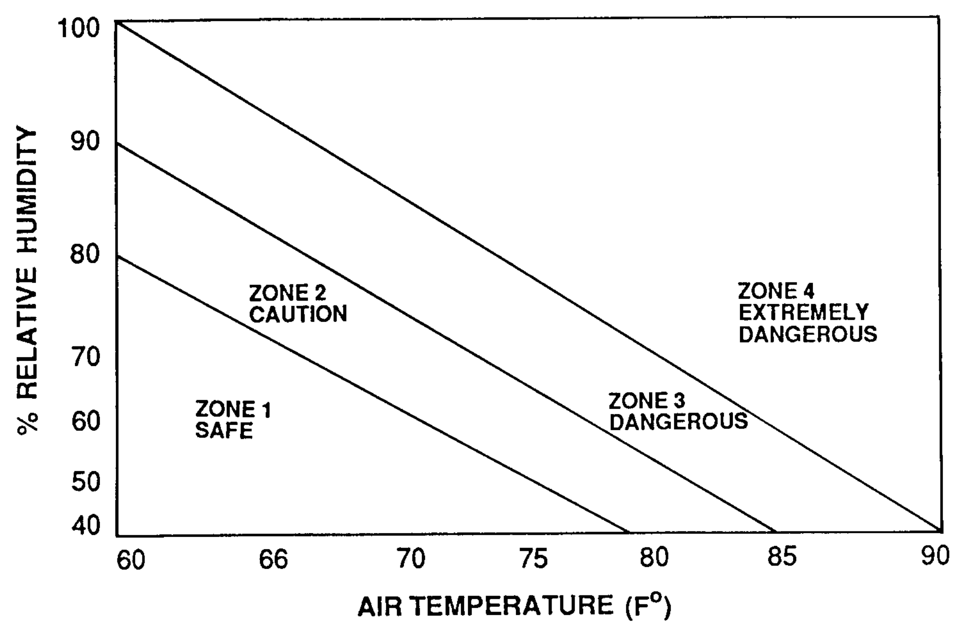
APPENDIX B.

HEAT STRESS / WIND CHILL CHARTS

RELATIVE HUMIDITY	AIR TEMPERATURE 70	75	90	85	90	95	100	105	110	115	120
	APPARENT TEMPERATURE (See note)										
0%	64	69	73	78	83	87	91	95	99	103	
10%	65	70	75	80	86	90	95	100			
20%	66	72	77	82	87	93	99				
30%	67	73	78	84	90	96	104				
40%	68	74	79	86	93	101					
50%	69	75	81	88	96						
60%	70	76	82	90	100						
70%	70	77	85	93							
80%	71	78	86	97							
90%	71	79	88								
100%	72	80	91								

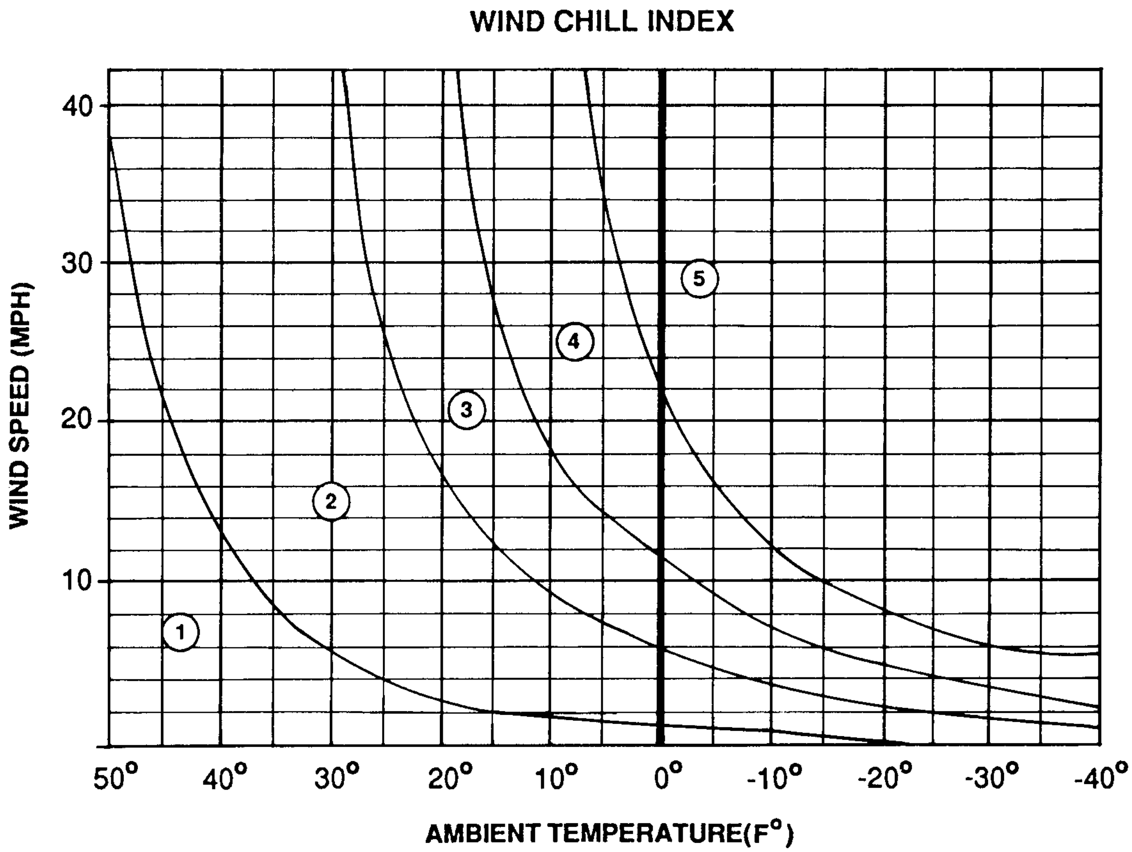
EXTREMELY DANGEROUS

NOTE: Degrees Fahrenheit



Zone 1 Safe
Zone 2 Caution (any combination of 160
Zone 3 Dangerous (Any combination of 175)
Zone 4 Extremely dangerous (any combination of190)

Figure B-1. Heat stress charts



LEGEND

(1) Comfort with normal precautions.

(2) Very cold; travel becomes uncomfortable on overcast days.

(3) Bitterly cold travel becomes uncomfortable even on clear sunny days.

(4) Freezing of human flesh begins depending upon the degree of activity, amount of radiation, and character of skin and circulation. Travel and life in temporary shelter become disagreeable.

(5) Survival efforts are required. Exposed flesh will freeze in less than one minute.

Figure B-2. Wind chill chart

APPENDIX C.

US LASER SPOT TRACKER SYSTEMS

Visual target acquisition is the single most significant problem in night CAS. Using ground and airborne laser designators and aircraft equipped with LSTs, however, significantly increases night CAS capability. The LSTs were developed for use on certain Tactical Air Forces, Navy, and Marine Corps aircraft. These acquisition systems allow air-to-ground aircrews to visually acquire and attack designated targets via laser energy reflected in the aircraft heads-up display and to attack them.[1]

CAPABILITIES

Visual acquisition of ground targets at night is normally impossible without natural or artificial illumination. With lasers and current NVDs, however, aircrews can acquire and mark specific targets. LST systems provide a means of target location and first-pass weapons delivery without the use of flares or other target lighting devices. For example, laser target designation by an Army fire support team ground/vehicle laser locator-designator (G/VLLD) should ensure positive target identification. The ALO, ETAC, and AFAC or fire support team, using built-in night optics, can study the target area in detail, then identify and designate the target for the aircraft. Aircrews can subsequently acquire the laser spot and attack without visually identifying the target.

As an example of LST effectiveness, Air Force pilots flying Pave Penny LST-equipped A-10 aircraft on night missions, with no moon, illumination, or flares of any type, have acquired and attacked targets with unguided general-purpose bombs and the GAU-8/A 30-mm cannon. Army Rangers designated these targets with LTDs, and the pilots achieved direct hits.

The AH-64 Apache helicopters also have the same LTD capability using the TADS. Army OH-58D Scout helicopters normally designate targets for the Apache Hellfire missile, which provides the same capability at night as Air Force A-10s (see discussion in Chapter 1).

LTDs and pinpoint weapons, such as laser-guided bombs and laser/IR Mavericks, can best meet the challenge of night flying close to urban complexes and friendly rear areas.

LST Tactics

INS allows pilots to proceed until a laser spot is detected and displayed. The aircrews can then attack the specific target area with virtually any conventional weapons. Aircrews can effectively employ not only laser-guided bombs but unguided ordnance in level or dive deliveries, or they can deliver forward-firing rockets and guns with increased accuracy. With this type of night employment, pilots can often engage targets before being detected.

1 For an extensive discussion on joint laser operations and systems, see JCS Publication 3-09.1 (Test), *Joint laser Designation Procedures.*

IR Maverick Tactics with LSTs

IR Mavericks, LSTs, and LTDs are fundamentally compatible. Air Force IR have the capability to engage point targets well beyond a pilot's visual acquisition range. LSTs allow the pilot to acquire and engage targets with IR Mavericks from stand off ranges. Without LSTs, the pilot is forced into visual acquisition range before he can employ the IR Maverick. See Appendix E for a description of the IR Maverick.

Laser Maverick Tactics

Laser Mavericks (LMAVs) are compatible with LSTs and LTDs. As with IR Mavericks, LMAVs are capable of standoff using LSTs. However, without LSTs, LMAVs may have a reduced employment range because pilots must visually acquire targets. The Navy and Marine Corps use LMAVs, but not the Air Force. See Appendix E for a description of the LMAV.

LIMITATIONS

Because hand-held LTDs lack stability and power, they have limited use with LST-equipped aircraft. Ground, vehicular, and airborne laser locator-designators would be easier to use and more effective for night LST employment. The availability of LST-equipped aircraft and ground laser equipment limits current LST tactical employment capability. Current and future laser capability will depend upon joint air-land laser training.

AIRCRAFT

Aircraft equipped with LSTs are able to detect reflected laser energy. These aircraft include the A-4M, A-6E, USAF A-7D, A-10, OA-10, AV-8B, and F/A-18.

Aircraft-mounted LTD systems are pod-contained or turret-mounted and have E-O laser target designating, ranging, and tracking capabilities. Aircraft equipped to carry these systems are the A-6E, F-4D/E, F-111F, F-16 [LANTIRN], F-15E, F/A-18, AC-130, OH-58D, and AH-64. These LTD systems provide laser tracking of ground targets for attacks with conventional ordnance or laser-guided weapons.

Most fighter/attack aircraft have the capability to perform night CAS missions under battlefield illumination and include the A-4, A-6E, A-7, A-10, AV-8, F-4, F/A-18 and F-111. Due to its limited availability and unique long range capabilities, the F-111 is not normally considered a CAS asset. Those capable of carrying target-marking flares are the A-6E, A-7, A-10, OA-10, F-4, F/A-18, OA-37, and OV-10.

APPENDIX D.

US GROUND-FORCE WEAPONS SYSTEMS

This appendix provides current information on night operations equipment available to US ground forces in the field. The information presented includes characteristics, capabilities, limitations, and uses of fielded night-operations equipment. It addresses individual, crew-served, and vehicular-mounted systems: NVDs, GSR, and sensors. See Appendix E for information on Army helicopters having night and adverse weather capabilities.

NIGHT VISION DEVICES

NVDs aid visual observation during periods of limited visibility: darkness, adverse weather, dust, smoke. These devices are categorized as either active or passive. Active devices emit energy to detect targets and can be detected by the enemy's acquisition systems. Passive devices detect targets by using low-level ambient light or thermal emissions and are less detectable by the enemy's acquisition systems. Enemy forces can be expected to use both active and passive techniques to defeat, degrade, or spoof personnel and E-O or IR sensors.

Technology

The two technologies currently used to detect enemy targets--image intensification and thermal imaging--are passive systems.

Image Intensification

Image-intensification devices improve visibility by amplifying moon and star illumination of a given area. However, as available light decreases due to cloud cover or the change of full moon to quarter moon, for example, the range and effectiveness of the devices also decreases. They also offset the effects intense, highly directional laser beams can cause to unprotected eyes.

Thermal Imaging

Thermal-imaging devices detect temperature differences and can be used in total darkness and during periods of limited visibility. These devices now make it possible to detect and recognize targets which would otherwise be undetectable by the unaided eye, daylight optics, or image-intensification devices in night situations. In adverse weather at night, as clouds and precipitation block illumination and as snow cover deny thermal contrast, thermal imaging capabilities become limited or ineffective.

A key challenge to using thermal night sights is that operators must interpret and understand the unusual images they generate. These images appear significantly different from ordinary visual pictures. Those technical characteristics which produce the variations in brightness levels on the display tube can also cause problems in target recognition for a gunner or observer. Targets stand out as images; they can be recognized at long ranges at night and at reduced ranges when obscured under adverse weather or battlefield conditions. If the radiated temperatures of a target and its background are the same, however, the target will not be distinguishable; in effect it will be invisible.

In some cases, targets travel over the background and heat or cool objects/surfaces, which creates hotspots sometimes mistaken as targets. For example, an aircraft exhaust heats the ground, or a tank track uncovers relatively warm mud under snow.

Temperatures within the target itself may be significantly different. The internal temperature variations of tanks, trucks, and armored personnel carriers form visible patterns that provide typical target signatures. Many viewers have white hot the hottest vehicle parts–engines and exhausts--stand out as bright/dark shapes. Medium-temperature objects, such as warm tracks, appear medium bright/dark, and the cooler parts, like a hull, appear dark/bright.

Atmospheric and battlefield observation conditions can degrade thermal signatures significantly. Precipitation, including rain, snow, and fog, tends to reduce the effectiveness of thermal sights since it reduces the apparent temperatures of both target features and background. Dust particles have much the same effect except that artillery impact dust degrades visibility even more. Visibility through diesel fog and smoke is very good depending on range. Thermal imaging devices are degraded if there is a long path length of the smoke cloud from fog oil.

During transition from day to night or night to day, the thermal contrast between the target and its background may reverse resulting in minimal target contrasts for several hours around dawn and dusk. This seriously degrades the use of IR weapons during these periods.

Equipment

Night-Vision Sights for Individual-Served Weapons

The first-generation AN/PVS-2B is a passive, battery-powered, E-O device which amplifies available light. It provides visual observation and sighting of weapons at night. With suitable brackets, the sight is compatible with M14 and M16 rifles, M79 grenade launchers, M67 90-mm recoilless rifles, and M60 machine guns. It may be employed in forward areas as a hand-held night viewer to detect and identify friendly and enemy activity.

The AN/PVS-4 is a second-generation starlight system (Figure D-2). It is smaller and lighter than the first-generation AN/PVS-2B. The biggest improvement of the AN/PVS-4 is that it does not white-out with bright lights, such as muzzle flash, flares, or fire. With suitable brackets, the AN/PVS-4 mounts on M14 and M16 rifles, M60 machine guns, M67 recoilless rifles, M72A3 light antitank weapons, and M79 grenade launchers. The AN/PVS-4 is replacing the AN/PVS-2B.

The AN/GVS-4 medium-range night-observation device is usually mounted on a tripod or vehicle. It is used to verify targets detected by GSR and may also be employed on outposts, listening posts, forward observation posts, and patrols.

Night-Vision Sights for Crew-Served Weapons

The AN/TVS-5 crew-served weapons night-vision sight is a light-weight, battery-powered, telescope-type passive sight (Figure D-1). It has replaced the AN/TVS-2B first-generation starlight scope now in the Army inventory. It has a 9-degree FOV and, with a suitable bracket, mounts on MK19s, M2 .50-caliber machine guns, M139 20-mm weapon systems, and M40I 106-mm recoilless rifles.

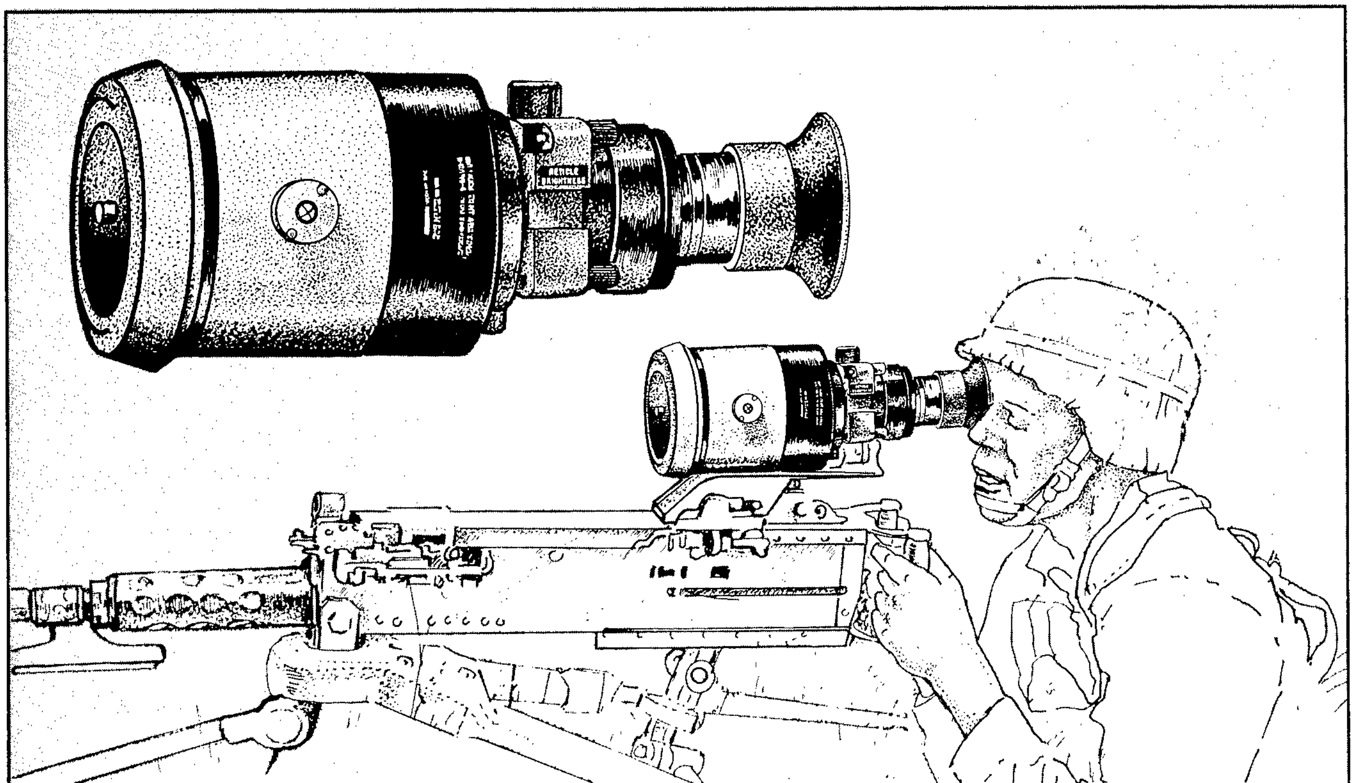


Figure D-1. AN/TVS-5 crew-served weapon night-vision sight

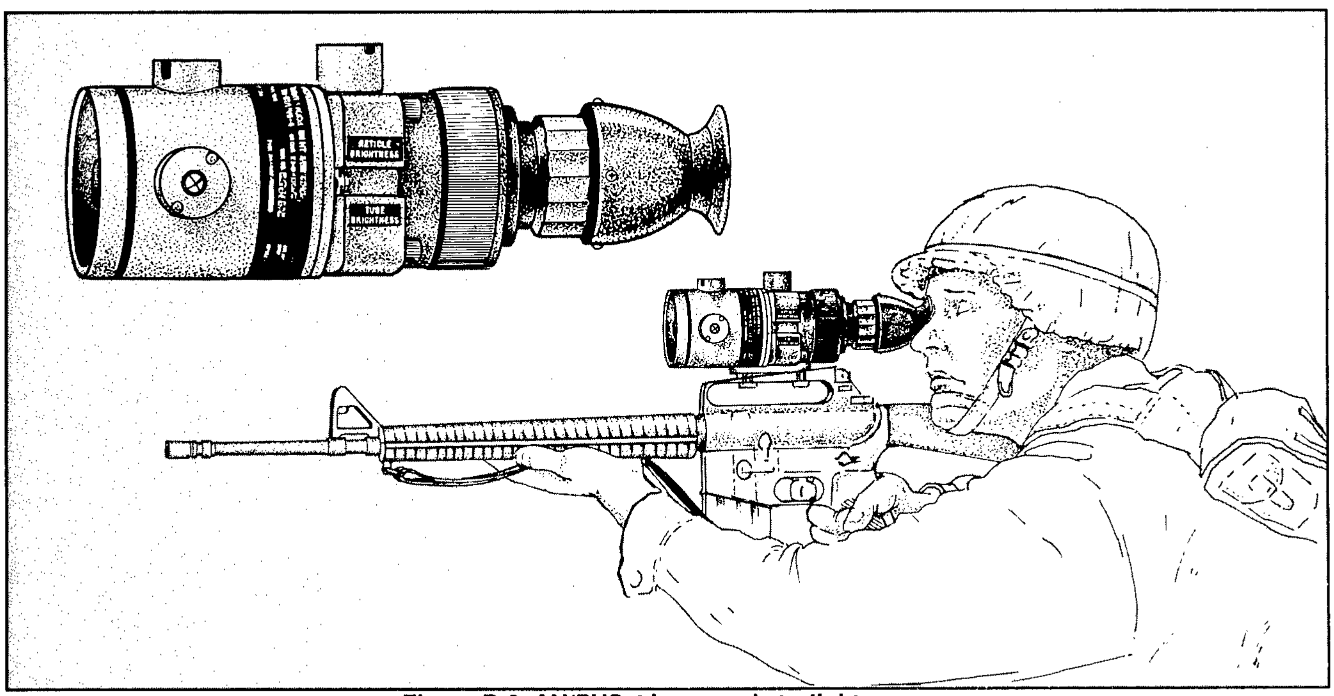


Figure D-2. AN/PVS-4 improved starlight scope

Night Vision Goggles

The AN/PVS-5 NVGs are lightweight, battery-powered, passive NVDs (Figure D-3). Worn on the head, the goggles can be used with or without standard battle or aviator helmet and provide capabilities for reading, performing manual tasks, patrolling, rendering medical aid, driving, walking, flying, and conducting surveillance. This device has a 40-degree FOV. The system is normally operated in the passive mode, but a built-in, active IR light source provides illumination for close-up viewing.

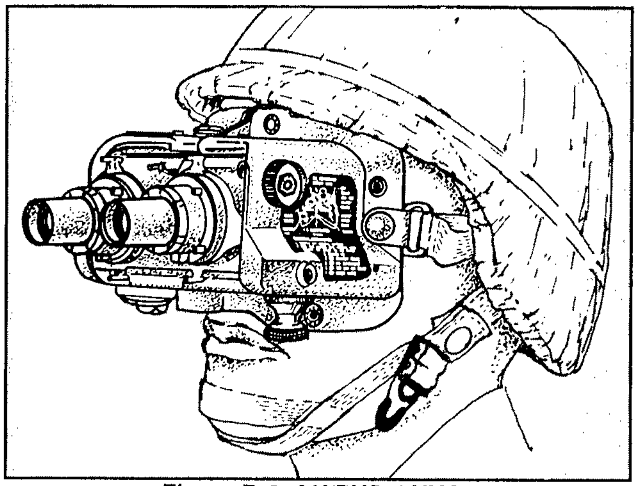


Figure D-3. AN/PVS-5 NVGs

The AN/PVS-7 NVGs are lightweight, battery-powered devices worn on the head. Two versions of the AN/PVS-7 goggles are currently in production--the AN/PVS-7A made by Litton Corporation (Figure D-4a) and the N/PVS-7B made by ITT/Varo Corporation (Figure D-4b). Their functions are similar, but their components are not completely interchangeable. They are designed for use during combat while the user is alone or in NBC protective clothing. They are compatible with the current issue M17A1, M24, and M25 protective masks. The single-tube, 18-mm, third-generation goggles will replace the AN/PVS-5.

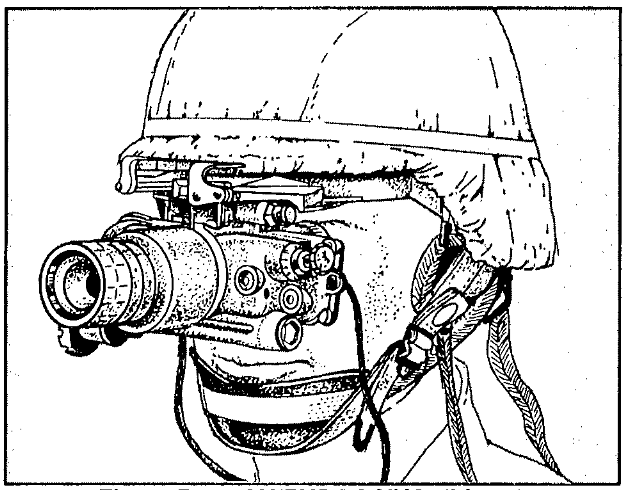


Figure D-4a. AN/PVS-7A NVGs(Litton)

They provide better night vision at lower light levels than the AN/PVS-5 goggles. Each device consists of a single-objective lens, a third-generation 12-tube assembly, and a beam-splitter, dual-eyepiece assembly. The device has an IR light source to provide illumination for close-up viewing.

The AN/PAS-7 hand-held thermal viewer is a small, lightweight, passive device used for target detection during day or night operations (Figure D-5). The viewer operates by detecting thermal radiation from viewed objects.

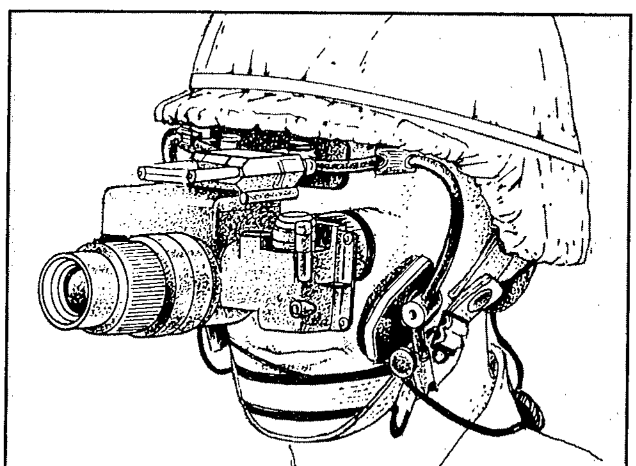


Figure D-4b. AN/PVS-7B NVGs (ITT/Varo)

The AN/TAS-6 long-range, night-observation device is a passive, tripod-mounted night sight which detects thermal radiation emitted by a target. This device is designed for surveillance only and has not been configured as a weapons sight. Its housing permits a mounting pad for the AN/GVS-5 hand-held laser range finder. The sight may be used night or day and will detect targets during limited visibility and through light foliage.

The AN/TAS-5 Dragon thermal night sight detects and displays on a screen the thermal energy emitted by all objects (Figure D-6).

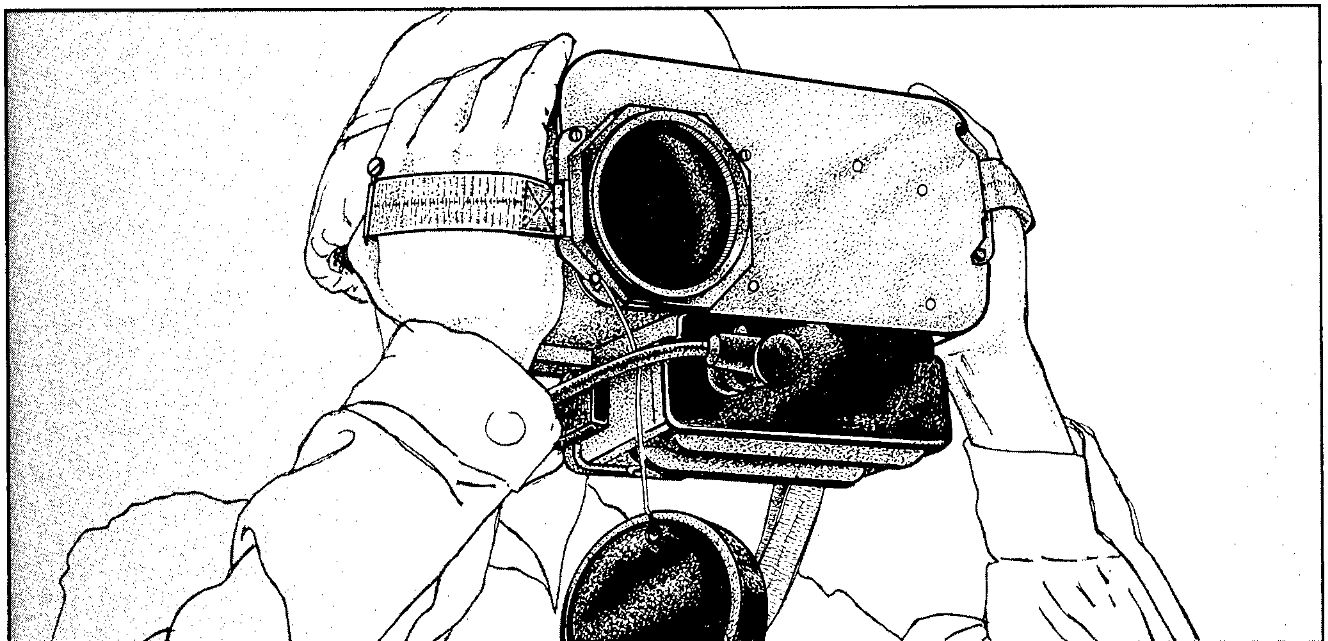


Figure D-5. AN/PAS-7 Hand-held thermal viewer

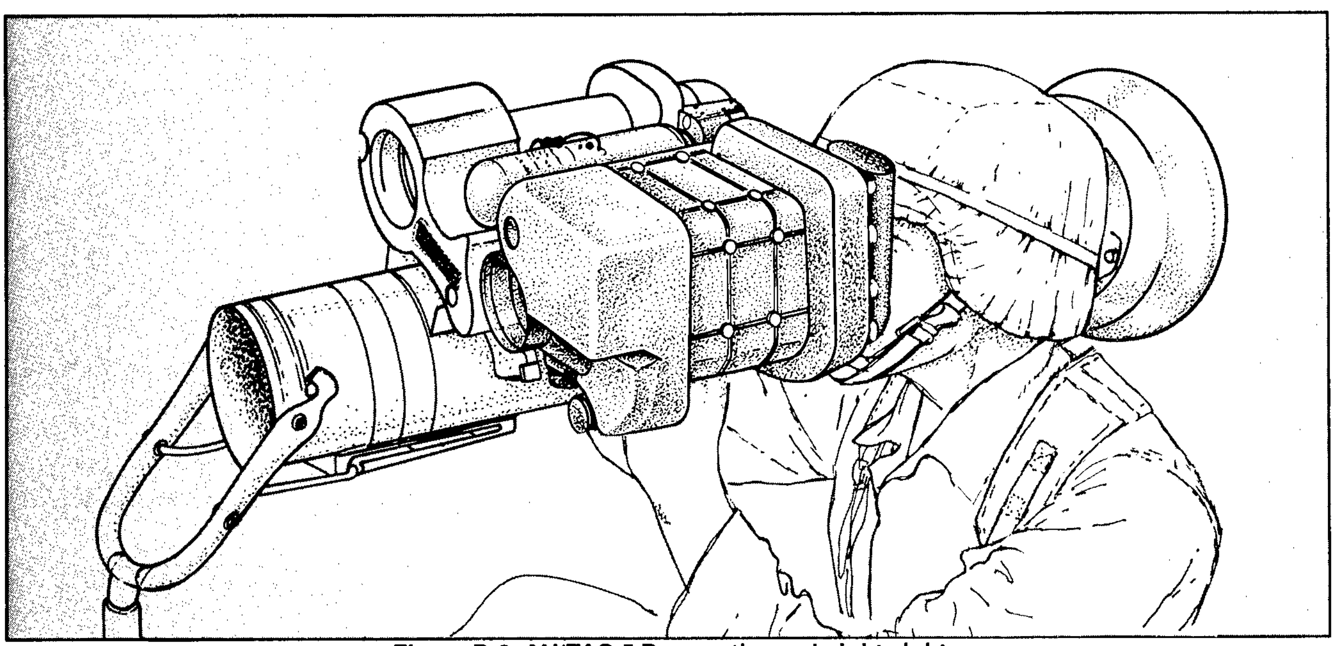


Figure D-6. AN/TAS-5 Dragon thermal night sight

The AN/TAS-4 tube-launched, optically-tracked, wire-guided (TOW) missile thermal night sight uses the latest state-of-the-art advances in thermal imagery to provide a lightweight, long-range nighttime capability to detect all natural or man-made objects.

The AN/VSG-2 tank thermal sight is a daylight sight (1x and 8x) combined with a thermal sight. The tank thermal sight and a laser range finder are coupled to an onboard ballistic computer to form a highly sophisticated fire control system. This sight is used exclusively with the M60 A3 tank; however, the M1 has a version of this sight with the same characteristics.

The Cobra Night is a thermal sighting system for the AH-1 TOW missile, 2.75-inch rocket, and 20-mm cannon. It can be used during day, night, limited visibility, and adverse weather conditions. The laser-augmented airborne TOW missile is integrated into the overall system.

The target-acquisition designation sight is the system used by the AH-64 attack helicopter (Figure D-7). It has laser designation and range-finder capabilities for use with the Hellfire missile. Primarily, copilot gunners use it to detect, acquire, and engage targets. The system has a multiple FOV. Its cathode ray tube display also indicates aircraft magnetic bearing, aircraft speed, and radar altitude. This system may also be used as the pilot FLIR system backup in case the pilot's night-vision sensor (PNVS) fails.

The PNVS is a FLIR system mounted in the AH-64 attack helicopter (Figure D-7). The image is displayed in the eyepiece mounted to the pilot's helmet. The system displays not only FLIR imagery but also symbols to aid in cruise, transition hover, and tactical/terrain flight.

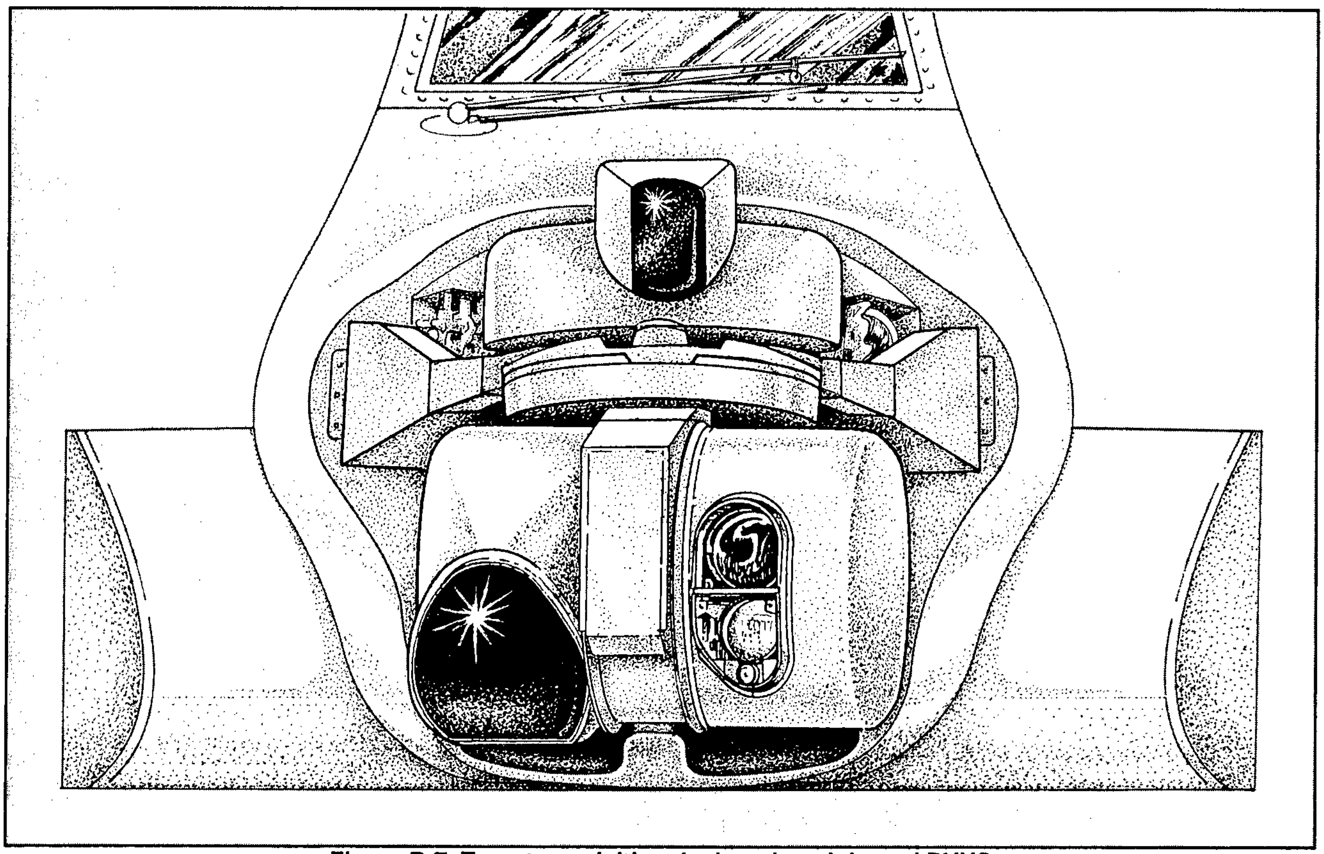


Figure D-7. Target acquisition designation sight and PNVS

The mast-mounted sight incorparates a TV camera, a thermal imaging system, and a laser designator/range finder (Figure D-8). This sight has narrow or wide FOVs in either day-TV mode or thermal-imaging mode. The thermal-imaging system provides for sighting, surveillance, and navigation. The sight's laser designator/range finder can designate targets for laser-seeking weapons. It can also accurately determine distance and direction from the helicopter to an intended target. The mast-mounted sight is mounted on the OH-58D.

IR Aiming Light

The AN/PAQ-4 IR aiming light provides a small, invisible light beam along the weapon's line of fire. Only night-vision equipment, such as the AN/PVS-5, can detect the light. The light attaches to the M16A1/A2 rifle.

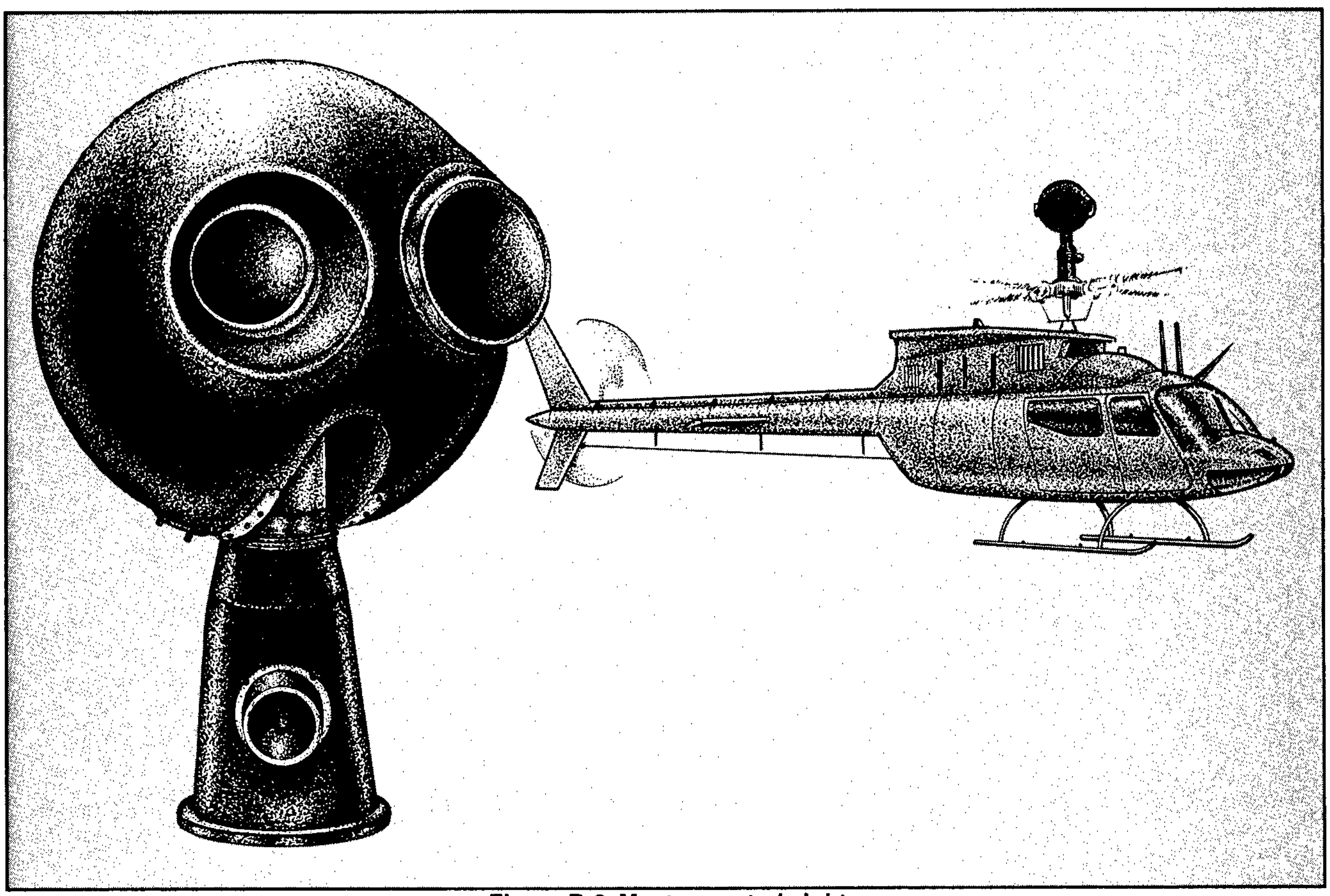


Figure D-8. Mast-mounted sight

Driver's Night-Vision Viewer

The AN/VVS-2 driver's night-vision viewer uses the same image intensification tube used in the and crew-served sights for infantry applications (Figure D-9). This periscope allows closed-hatched driving for combat vehicles, specifically the M60 tank, M1 tank, and the M2/M3 fighting vehicle systems.

Aviator's Night-Vision Imaging System

The AN/AVS-6 aviator's night-vision imaging system (ANVIS) is a high-performance, lightweight, passive, third-generation image-intensifier system (Figure D-10). Its design is specifically for helicopter pilots to use for night and nap-of-the-earth flying. This system greatly enhances the capabilities of the original ANVIS.

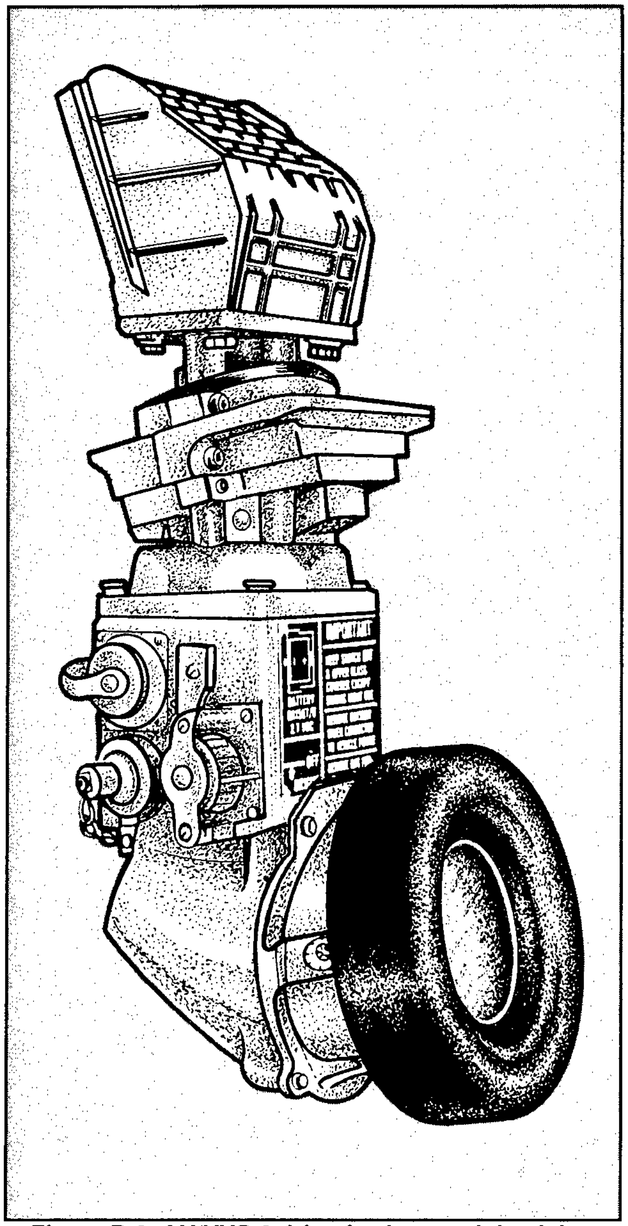


Figure D-9. AN/VVS-2 driver's viewer, night vision

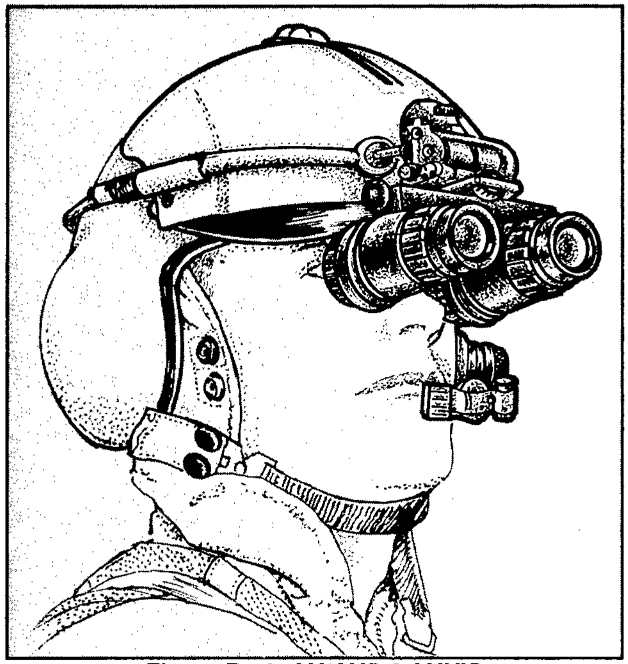


Figure D-10. AN/AVS-6 ANVIS

NONOPTICAL DEVICES

Nonoptical devices are systems that use nonvisual or image-enhancing devices to detect enemy targets. These systems are categorized as radars or sensors.

GSR Systems

GSR system equipment provides an adverse weather, 24-hour, battlefield surveillance capability for detecting and locating targets.

The radar transmitter generates an ultrahigh RF which will, upon striking an object, reflect back to the radar receiver to present an audio and/or visual display.

Radar energy can penetrate light camouflage, smoke, haze, light rain, light snow, darkness, and light foliage to detect targets. Current US ground force systems, however, will not penetrate heavy rain and snow, dense undergrowth, trees, and heavy foliage. They are also vulnerable to jamming and other deceptive means and are limited to LOS detection.

Table D-1 shows the detection capabilities of current ground-force systems. See Figure D-11 for AN/PPS-5B and Figure D-12 for AN/PPS-15(V)1.

Table D-1. Detection capabilities of ground-force systems

	AN/PPS-4	AN/PPS-5	AN/PPS-15
Detects personnel at	1,500 m	6,000 m	3,000 m
Detects vehicles at	6,000 m	10,000 m	3,000 m

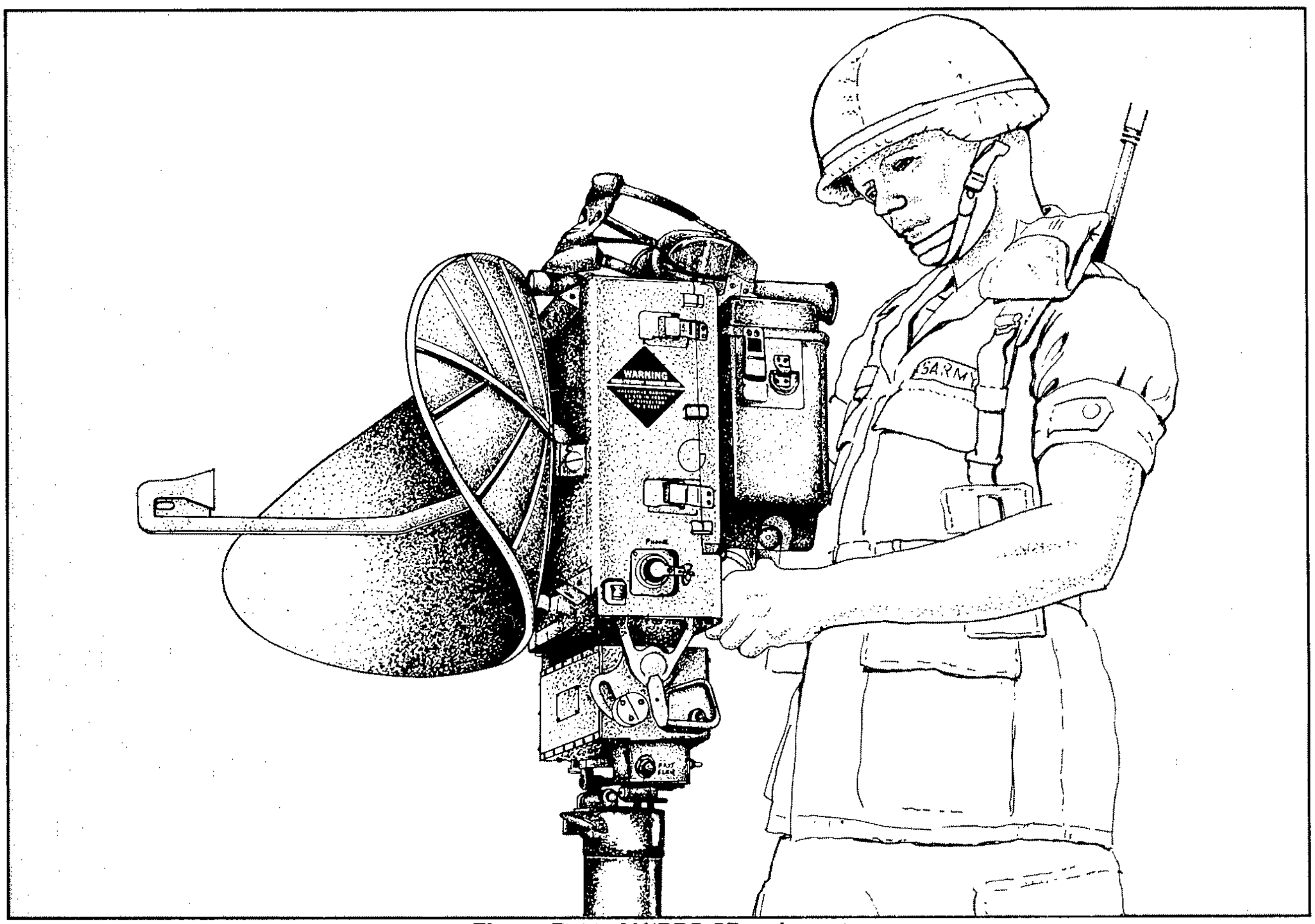


Figure D-11. AN/PPS-5B radar set

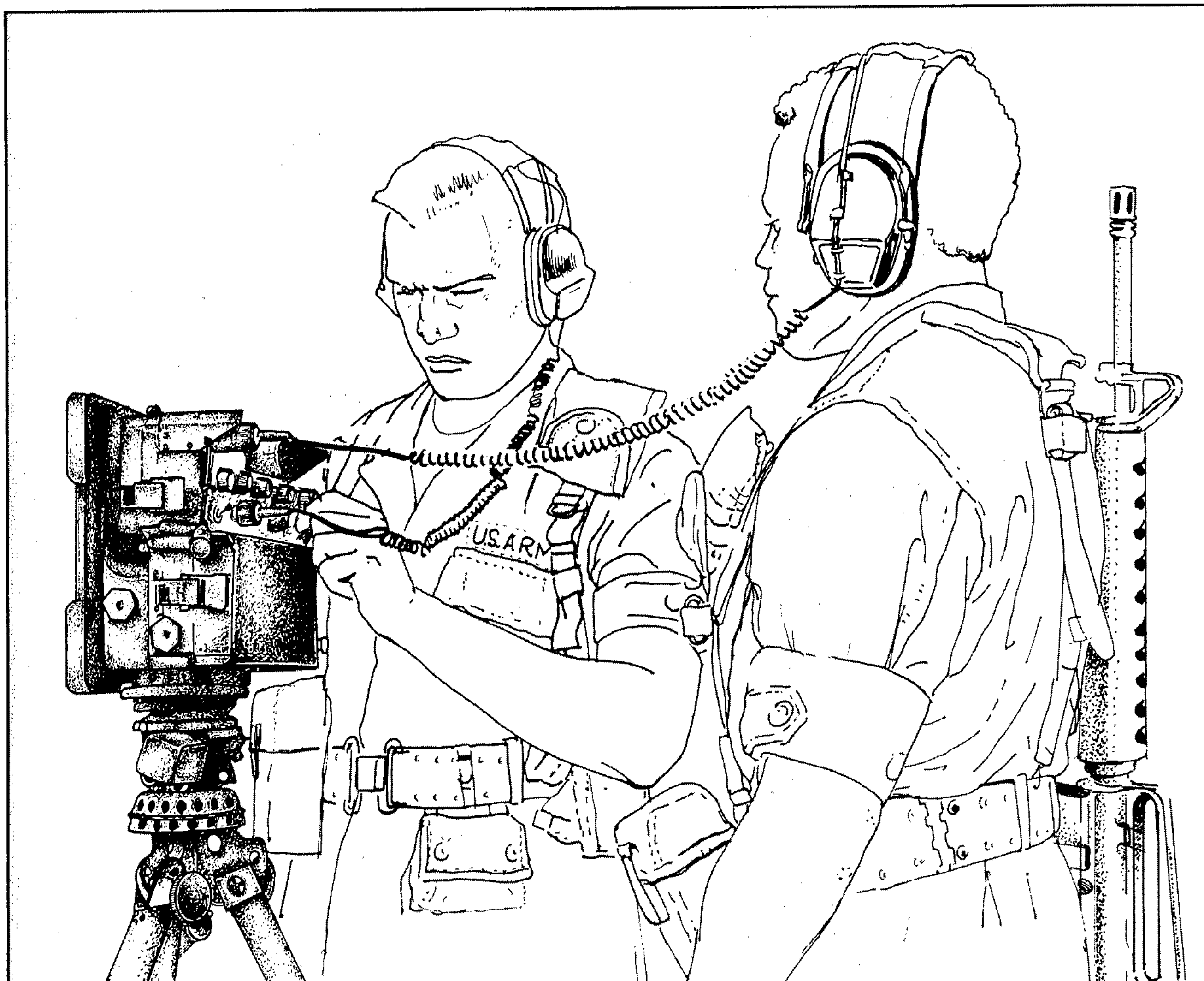


Figure D-12. AN/PPS-15(V) 1 radar set

Remote Sensor Systems

Remote sensors are among the newer items to be added to the reconnaissance, surveillance, and target acquisition family. Remote sensors are used extensively in surveillance missions, but their ability to electronically locate targets also makes them vulnerable to enemy ECM.

Remote sensor systems usually consist of a number of sensors and a monitor which may vary in sophistication with the system. Both the sensors and the monitor are usually radio-linked, although some newer systems include an optional wire-link mode.

The current remote sensor system is the remotely monitored battlefield sensor system (Figure D-13). The system is man-portable and hand-emplaced. It detects movement of vehicles and personnel by magnetic, seismic/acoustic, and IR (passive) sensing. The sensors have a built-in antitamper system that disables the sensor when tampered with. The LOS transmission distance from the sensors to the monitor is 15 kilometers (ground to ground) and 100 kilometers (ground to air). Transmissions over rough terrain may require emplacing repeaters. Table D-2 shows the detection capabilities of the system.

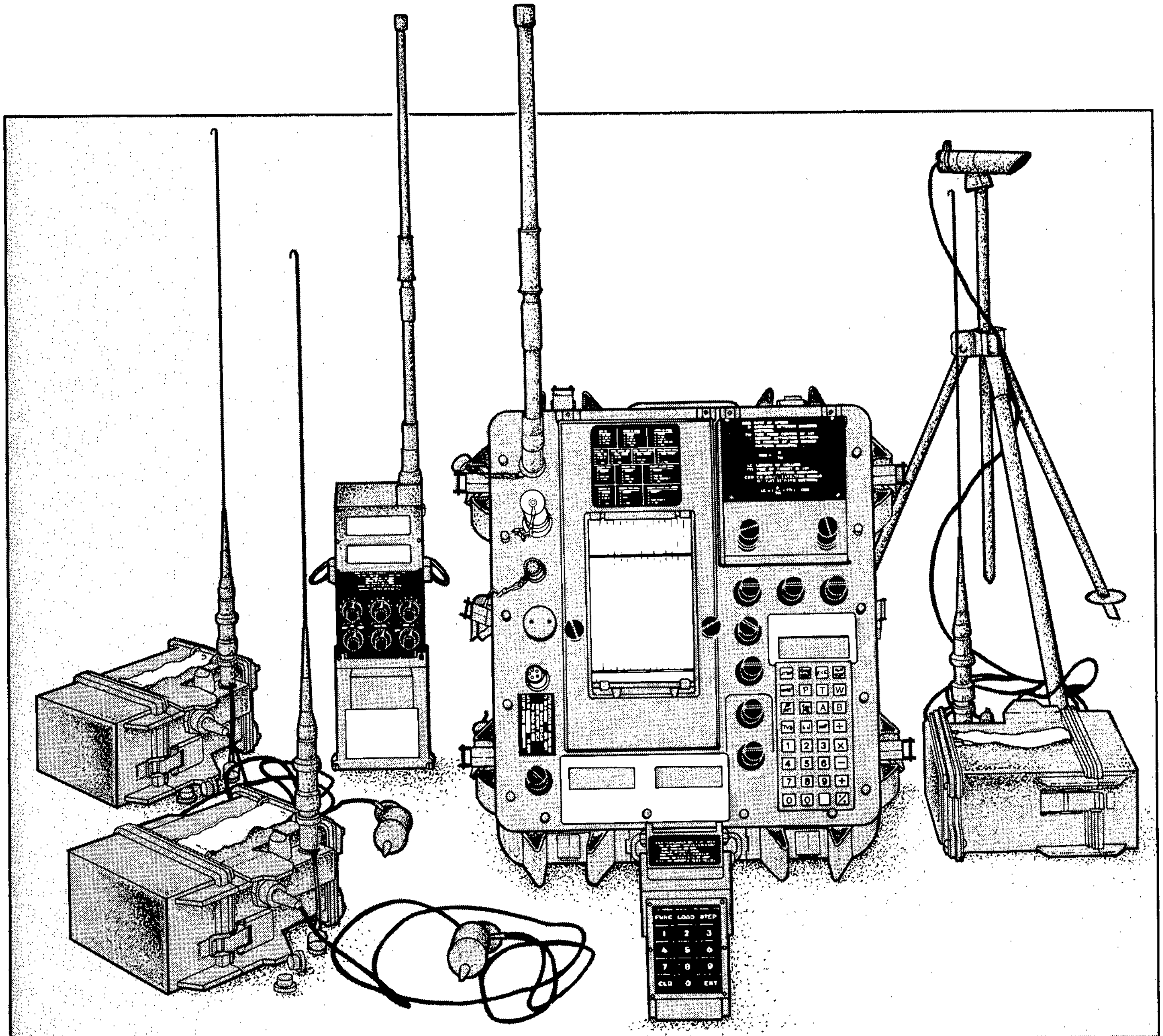


Figure D-13. Remotely monitored battlefield sensor system

Table D-2. Detection capabilities of remote sensor systems

	Seismic/Acoustic	Magnetic	IR
Detects personnel at	50 m	3 m	3-20 m
Detects wheeled vehicles at	250 m	15 m	3-50 m
Detects tracked vehicles at	350 m	25 m	3-50 m

Magnetic

Magnetic sensing detects ferrous (iron or steel) objects moving through a magnetic field. Magnetic sensing is effective in tracing the movement of vehicles and, when coupled with another type of sensor, can confirm the presence of enemy activity. Magnetic sensors can provide direction of travel and approximate count of objects containing ferrous metal.

Seismic/Acoustic

Seismic/acoustic sensors can provide classification of targets by analyzing seismic and acoustic patterns. They are limited by the same factors as the seismic sensors.

IR

IR (passive) sensors detect thermal changes within the target area.

They can provide direction of travel and approximate count of objects passing through the detection area. Because IR (passive) sensors detect thermal change objects that are moved by wind, for example, dust, tall grasses and leaves, these objects may cause false activations.

Pressure

A pressure sensor registers pressure caused by a passing intruder. Typically, a liquid-filled hose is buried along a potential route of intrusion. As the intruder's weight compresses the soil around the hose, the device transmits a warning. Pressure-sensing devices are extremely sensitive to the type of terrain and to the weather. In cold climates, frozen ground or snow may make the device useless. Normally, pressure-sensing systems are employed around fixed locations when the installation time is not critical and the installation needs to be permanent.

APPENDIX E.

US AIRCRAFT AND WEAPONS SYSTEMS

For a description of all night-capable laser systems, refer to JCS Pub 3-09.1 (Test). For a description of all night-capable beacon systems, refer to Multi-Service Procedures for Radar Beacon Operations, FM 90-17/MACP 55-11/TACP 50-39/ FMFRP 2-74. For additional information on the weapons systems used during night and adverse weather operations and described in this appendix, consult the individual service manuals listed in the references.

AIRCRAFT	CAPABILITIES	LIMITATIONS
6E Target-Recognition tack Multisensors 3AM) Aircraft avy/Marine Corps)	This aircraft has an electro-optical sensor, FLIR, combination laser designator/range finder, and a laser designator receiver. It has an operational weapons-delivery platform and is capable of night surveillance and attack and delivery of laser-guided munitions. The aircraft has radar beacon forward air controller (RABFAC) capability. The terrain-clearance radar capability allows aircraft to operate in a night limited/adverse weather, high-threat environment.	The aircraft system cannot *see* through clouds, precipitation, or fog.
w Altitude Navigation, rgeting Infrared Night ANTIRN) System r Force) 15E and limited F-16 tforms	This is a two-pod-mounted system that will permit equipped attack aircraft to acquire, track, and destroy ground targets with both guided and unguided weapons. The navigation pod has a FLIR sensor and TFR. The targeting pod has a FLIR sensor, laser designator and range finder, automatic target tracking, and a missile boresight correlator. The TFR enables the pilot to operate at very low altitudes with en route weather penetration and blind let-down capability. The navigation pod alone allows accurate weapons delivery against point or area targets using visual employment techniques. The targeting pod is designed to be effective against targets as small as tanks. It adds LGB capability and enhances the IIR Maverick.	The system provides only forward FOV and thus does not permit the high-g daylight maneuvers normally used in terrain masking and reattacks. It cannot use the targeting pod for accurate PGM delivery if clouds, precipitation, or fog obscure the target area. However, the navigation pod's TFR and the aircraft's ground radar can still provide low-level area target capability.
FB/EF-111 Aircraft r Force)	This aircraft has an internal, automatic TFR system and can provide around the clock air-to-surface bombing (F/FB-111) with jamming (EF-111) under all weather conditions when coupled with precision navigation and radar systems. The automatic TFR provides hands-off descent to low altitude, high speed flight conditions at night and/or in adverse weather. This combination gives maximum aircrew survivability in mid- and high-threat areas, avoiding or minimizing exposure to most enemy weapons systems. The system also has a terrain-avoidance mode which provides continuous indications of terrain at or above the aircraft's flight path. The F/FB-111 radar is optimized for low-altitude operations, allowing accurate low-level navigation and radar-synchronous weapons deliveries at night and adverse weather conditions. The EF-111 has similar navigation for precise jamming operations.	The use of radar for terrain following and navigation provides excellent capability against area and point targets but is degraded during moderate to heavy rain showers and thunderstorms.
17A	This fighter is the world's first operational aircraft designed to exploit low observable stealth technology. It is a single-seat fighter designed to penetrate dense threat environments, day or night, and attack high value targets with pinpoint accuracy. The F-117A can employ a variety of weapons and is equipped with sophisticated navigation and attack systems integrated into a state-of-the-art digital avionics suite that increases mission effectiveness and reduces pilot workload. Detailed mission planning is accomplished by an automated mission planning system developed specifically to optimize the unique capabilities of the F-117A.	Classified
-130 Specter Gunship r Force)	The AC-130 can use its visual and electronic sensors to precisely deliver munitions to provide CAS, interdiction, armed reconnaissance, unconventional warfare (UW), collective security, convoy escort, helicopter escort, and SAR. The AC-130A can be employed in a low threat environment, while the AC-130H can conduct operations in a medium threat environment with nonintegrated radar threats. The AC-130 can operate in all types of climates to support its global commitments. Unrefueled mission endurance is five hours. The aircraft's armament includes 20-mm cannons for use against personnel under light cover and trucks, 40-mm for use against personnel under medium cover, trucks, etc., and 105-mm which is only on the AC-130H for use against personnel under any cover, trucks, or mobility kills to tanks. Ammunition includes high explosive, white phosphorous, high explosive incendiary (HEI), and HEI special (misc).	Present AC-130s can only deploy at mid-altitudes (10,000' MSL or lower) due to the lack of pressurization. AC-130 weapons must be boresighted prior to fire missions close to friendly forces. Current aircraft ECM systems are for defensive use only and do not increase loiter time in a threat area. Interdiction and CAS missions in a high air threat environment may not be feasible with an AC-130H. Missions in most mid-threat and all high-threat target areas require tactical threat suppression support. Mission duration is limited by environmental stress on the crew and availability of air refueling.

AIRCRAFT	CAPABILITIES	LIMITATIONS
30 Specter Gunship ·orce) ·inued)	The TV laser systems provide low-light-level TV (LLLTV) during darkness and laser designation of targets. Using IR strobes, reflective panels, or reflective tape can enhance TV location of friendly positions. The IR detection system provides a visual presentation of the temperature differential between objects. The present Temig beacon and Black Crow have a limited capability of supporting adverse weather roles such as convoy escort, point target destruction, and interdiction. The AC-130's ASD-5 Black Crow and APO-150 radar are beacon-compatible systems which permit area ordnance delivery versus the surgical application of firepower.	High basic aircraft gross weight and drag index decreases mission duration (i.e., increased fuel consumption and tanker support requirements). The AC-130's sensor system is not all-weather capable. LLLTV and IR detection systems require visual meteorological conditions (VMC). The IR system is degraded during sunrise and sunset, and the LLLTV is adversely affected by haze, smoke, and other obstructions to vision. Search and rescue and aircraft interdiction are beyond the gunship's adverse-weather capability.
30P/N Air eling Tankers ·orce)	This aircraft can conduct clandestine formation and single-ship intrusion of hostile territory to provide serial refueling or establish forward area arming and refueling points (FAARPs) for helicopter operations.	Two-ship tanker elements will be the minimum planned for operations since an airborne spare is highly desirable. Three-ship elements will normally be the maximum used since larger tanker formations are not operationally feasible. All HC-130 aircraft have limited (6-10 man) personnel airdrop capability. No HC-130s are in-flight refuelable which adversely affects their ability to fully support the long-range mission. The lack of in-flight refueling capability limits range, significantly increases the number of tankers required, and may require prepositioning of tankers, thus increasing the likelihood of mission compromise. The HC-130 has no low-level adverse weather penetration capability. Only a limited number of aircraft are modified for NVG landings or have EW equipment to penetrate low to medium air threat environments.
130 Combat Talon ·orce)	This aircraft can conduct long range infiltration, resupply, and exfiltration of unconventional warfare forces using all-weather TF/TA radar; inertial navigation system; forward-looking infrared sensor; secure communications; electronic countermeasures; inflight refueling; and high-speed ramp. This aircraft has a terrain-following radar system that is all-weather and designed to provide a 65' wingtip clearance from obstructions, when flying at 250' AGL. The radar displays all terrain/obstacles above the current aircraft altitude. Navigational accuracy is maintained by the inertial navigation system. It provides the capability to conduct blind drops and autonomous glide-slope solutions for blacked-out landing operations. The FLIR sensor is used to aid in position accuracy, as well as terrain avoidance. The MC-130 crew has the ability to counter most threats using IRCM pods, chaff, flares, and other electronic countermeasures. The ramp and door can be opened at speeds up to 250 KIAS which reduces detection and/or compromise of drop zones. Specifically configured air drop bundles rigged with high-speed parachutes enable the MC-130 to airdrop up to 2200 lbs from 250' AGL at 250 KIAS. The MC-130 has the capability to fly NVG approaches to a completely blacked-out runway, land, and then take off without any assistance from a ground party. The INS provides an internal glide slope/ILS the copilot flies until the aircraft commander takes over visually for the NVG landing.	Terrain-following capability is degraded during moderate to heavy showers and thunderstorms. FLIR system cannot be used in areas of precipitation due to possible equipment damage.

?CRAFT	CAPABILITIES	LIMITATIONS
Combat Talon e) d)	To exfiltrate personnel/equipment, the MC-130 crew can employ the Fulton surface-to-air recovery system. The present system can retrieve up to 500 lb of personnel/equipment. The range of the MC-130 is essentially unlimited due to its in-flight refueling capability. Specially configured MC-130s can transfer fuel to helicopters while in flight or on the ground. Given precise conditions or a beacon at the objective area, the MC-130 can locate a target in all weather conditions to include airdrop operations under zero visibility. A four-function forward-looking radar provides precision ground mapping, weather detection, and beacon interrogation. A FLIR provides the capability to backup night airdrops using the precision radar system by visually identifying unmarked equipment.	
olly Green Giant e)	When equipped, the HH-3E employs deceptive IR countermeasures and passive warning systems to avoid detection by air defenses. HF radio capability permits long-range communications beyond that of line-of-sight systems. With air refueling, the only range limitation is crew endurance. Unrefueled combat radius is 210 NM. The HH-3E can operate in unprepared, unlighted, and uncontrolled landing zones having a diameter of 50 meters or more.	With air refueling, the only range limitation is crew endurance. The HH-3E has limited self-defense capability with the installation of up to two 7.62 machine guns. Air-to-air defensive missiles are not installed on the HH-3E, limiting defensive tactics to evasive maneuvering. The HH-3E lacks a TF or TA radar capability. HH-3E operations depend on VMC conditions in the objective area. The HH-3E will not be employed in mid or high air threat environments.
(Helicopter	This helicopter is capable of conducting covert, long-range infiltration, exfiltration, and resupply of SOF personnel and equipment. It engages in counterterrorism, reconnaissance, direct-action, and strike missions during day or night in adverse weather or during reduced visibility. The MH-47X can ingress and egress at a low level at night and during limited adverse weather by using NVGs and FLIR. It has the capability to videotape FLIR output during missions and to use the aviator's ANVIS display symbology system (ADSS), which provides basic aircraft flight information to the flight crew. It can operate in unprepared, unlighted, and uncontrolled landing zones.	The MH-47X cannot *see* through clouds, precipitation, or fog but can fly under clouds if the ceiling permits.
Pave Low III ce)	The MH-53J has the capability to employ deceptive electronic/IR countermeasures and passive warning systems to avoid detection by air defenses. MH-53J aircraft are equipped with in-flight refueling, TF/TA radar, forward-looking infrared and INS/GPS/doppler navigation systems to provide precise low altitude navigation capability. SATCOM and HF radio capability permits long-range communications beyond that of line-of-sight systems. The TF system is optimized at 100 knots, however the helicopter can cruise at speeds up to 130 knots and has a dash speed of 162 knots. With air refueling, the only range limitation is crew endurance. Unrefueled combat radius carries from 200 to 300 NM depending on payload. The MH-53J can operate in unprepared, unlighted, and uncontrolled landing zones having a diameter of 75 meters or more.	With air refueling, the only range limitation is crew endurance. The MH-53J has a limited self-defense capability with the installation of up to three .50 caliber machine guns. Air-to-air defensive are not installed on the MH-53J, limiting defensive tactics to evasive maneuvering. Operations may be limited by heavy precipitation, icing, low visibility, high temperature, and high density altitude.

AIRCRAFT	CAPABILITIES	LIMITATIONS
MH-60G Pave Hawk (Air Force)	The MH-60G is capable of supporting special operations and combat rescue. The MH-60G employs deceptive electronic/IR countermeasures and passive warning systems to avoid detection by air defenses. The aircraft are equipped with in-flight refueling, weather-avoidance radar, and INS/doppler navigation systems to provide precise low altitude navigation capability. SATCOM and HF radio capability permits long-range communications beyond that of line-of-sight systems. Unrefueled combat radius is 230 NM when equipped with dual 185-gallon internal auxiliary fuel tanks. The MH-60G can operate in unprepared, unlighted, and uncontrolled landing zones having a diameter of 50 meters or more.	With air refueling, the only range limitation is crew endurance. The MH-60G has a limited self-defense capability with the installation of up to two .50 caliber machine guns and two GAU-2B (7.62 mm) miniguns. Air-to-air defensive missiles are not installed on the MH-60G, limiting defensive tactics to evasive maneuvering.
MH-60K Helicopter (Army)	The MH-60K helicopter is capable of conducting covert, long-range infiltration, exfiltration, and resupply of SOF personnel and equipment. The MH-60K can ingress and egress at a low level at night and during limited adverse weather by using NVGs and FLIR. It has the capability to videotape FLIR output during missions and to use the ADSS, which provides basic aircraft flight information to the flight crew. It can operate in unprepared, unlighted, and uncontrolled landing zones. It is capable of performing shipboard operations in all blackout conditions and has high-energy, field-strength capability.	The MH-60K cannot *see* through clouds, precipitation or fog, but can fly under clouds if the ceiling permits.
B-1B System (Air Force)	The B-1B system has an internal, automatic TFR system which, as part of the OAS package, provides around-the-clock air-to-surface bombing capabilities in day, night, and adverse-weather conditions. The automatic TFR provides a hands-off descent to low-altitude, high-speed flight conditions at night and during limited adverse weather. The B-1B is capable of accurate low-level navigation and radar-synchronous weapons deliveries at night and during adverse weather conditions.	Its terrain-following capabilities are degraded during moderate to heavy showers and thunderstorms. It has not been certified for carrying conventional weapons at present. Currently, the B-1B will primarily support SAC nuclear missions.
B-52 Electro-Optical Sensors (Air Force)	The B-52 sensors provide 24-hour strike capability to perform interdiction or CAS. The system provides night and under-the-weather attack capability by presenting the pilot with real-time passive thermal imagery. It uses a TV-formatted display for locating and identifying targets. It can automatically track selected targets. The design provides for incorporating laser designators and range finders.	Its terrain-avoidance capability is degraded during moderate to heavy showers and thunderstorms. The LLLTV and FLIR cannot *see* through clouds, precipitation, or fog but can be used under clouds if ceilings permit. The LLLTV is adversely affected by haze, smoke, and other obstructions to vision, and the FLIR system is degraded around sunrise and sunset.

EQUIPMENT	CAPABILITIES	LIMITATIONS
A-7 FLIR System (Air Force/Navy)	The FLIR enables A-7 pilots to carry out CAS, interdiction, and surveillance/reconnaissance missions by day or night.	The Navy A-7 has no laser spot tracker. The FLIR cannot *see* through clouds, precipitation, or fog.
A-7 Low-Altitude Night Attack (LANA) System (Air Force)	This system provides around-the-clock, under-the-weather, air-to-surface attack capability. The FLIR scene can be displayed heads-up on a wide FOV HUD or heads-down on a radar display. The ATF system provides the capability to safely fly hands-off at a low altitude with a selected terrain-clearance plane. The FLIR allows for night, under-the-weather, visual deliveries of free-fall and forward-firing ordnance. Limited through-the-weather terrain following navigation operations are possible.	ATF operations depend upon radar. The FLIR provides only forward-looking capability. Target acquisition depends on accurate navigation, due to the limited forward FOV. Rain and heavy precipitation degrade the ground mapping capability of the radar.

EQUIPMENT	CAPABILITIES	LIMITATIONS
rse-Weather Aerial ery System ADS) 0 platforms Force)	AWADS provides the capability to perform air-drop operations under conditions of zero visibility. AWADS-equipped aircraft can serve as pathfinders for SKE-equipped aircraft. A four-function forward-looking radar provides ground mapping, weather detection, precision ground mapping, and beacon interrogation. AWADS can be updated from ground aids such as tactical air navigation (TACAN) or beacons or from aircraft navigation systems such as the radar.	Rain and heavy precipitation degrade the ground mapping capability of the radar. Some geographical areas such as deserts may not offer suitable checkpoints or target identification points to give a good radar-return signature. In these instances, the AWADS depends upon beacons to be effective. Only a limited number of C-130s are equipped with AWADS (none in the Air National Guard).
18 FLIR System y/Marine Corps)	The F/A-18 FLIR system provides 24-hour strike capability to perform interdiction or CAS. The system provides night and under-the-weather attack capability by presenting the pilot with real-time passive thermal imagery. It uses a TV-formatted display for locating and identifying targets. It can automatically track selected targets. The design provides for incorporating laser designators and range finders.	The system has no laser capabilities. It cannot *see* through clouds, precipitation, or fog.
on-Keeping ment (SKE) ed C-141 and C-130 orms orce)	This is a multipurpose avionics system that permits formation flight of two or more aircraft during darkness or instrument meteorological conditions (IMC). The system allows up to 36 airplanes in formation to maintain separation from each other during day and night operations under adverse weather conditions. Coupled with AWADS lead aircraft or SKE zone markers, this system allows aircrews to perform airdrops under conditions of zero visibility or darkness.	The SKE has a limited number of frequencies and requires continuous transmission.
Tack and F-111F orms orce)	The Pave Tack is a pod contained, E-O weapons delivery system for use on high-speed, low-altitude aircraft. It provides an IR detecting set for target acquisition and precision laser designation, ranging, and tracking of ground targets. It can make attacks during the day, night, and limited adverse weather. The laser designator provides very accurate ranging for nonlaser guided bomb delivery and self-lasing for autonomous LGB/LLLGB delivery or *buddy* lasing for other aircraft.	Pilots cannot use the system if clouds, precipitation, or fog obscure the target area and if the ceiling is too low to fly under the clouds. Gimbal limits affect the designator aircraft's flight-path profile during the bomb's time of flight. The system requires a very high aircrew work load.
ion-Location rting System S) packs, aircraft, ce vehicle platforms ine Corps)	The PLRS is a UHF radio network consisting of a transportable master station with computers and situation display that communicates with up to 400 individual user units. These user units may be deployed as manpacks down to the platoon or patrol level and may be installed in aircraft and surface vehicles. The PLRS allows unit commanders to position assault units along an LOD to within a 10- to 20-meter tolerance. It enhances the effectiveness of tube launched, optically tracked, wire-guided (TOW) Cobra attacks on enemy armor. It provides control-point guidance and rendezvous navigation for CAS.	The PLRS requires LOS.
nned Aerial Vehicle) platform /)	The UAV is a remotely piloted vehicle that performs day and night reconnaissance, radio relay, and battlefield intelligence collection. It can be programmed to fly a set course or an operator on the ground can pilot it remotely. UAV systems, when fielded, will be able to conduct day or night operations during periods of adverse weather. The RPV can be controlled either by an operator from a remote location or by a preprogrammed course.	UAVs are light weight and susceptible to aircraft turbulence over rough terrain with high winds. Clouds at or below flight level will blind the optical and infrared imaging systems. Recovery using IR guidance can be degraded by falling precipitation. The system has limited availability. It is limited by extreme adverse weather such as gusting winds, snow, heavy rain. It has LOS limitations and discrimination of airborne sensors.

QUIPMENT	CAPABILITIES	LIMITATIONS
D Night ration System e Corps)	The aircraft has laser target-detecting, ranging, and tracking systems capability. The NOS is a night aerial-observer platform for a forward observer (FO) or FAC. The aerial observer controls fires for supporting aircraft, artillery and mortar batteries, and naval gunfire support ships. It can perform limited CAS. It acquires and designates targets through FLIR and an on-board laser ranger or designator.	The NOS has no laser spot tracker. It cannot *see* through clouds, precipitation, or fog.

ES AND BOMBS	CAPABILITIES	LIMITATIONS
65D/G Imaging d (IIR) Maverick -10, F-4, F-15E, 16A platforms rce)	AGM-65D variant has a large warhead with a shaped charge to enhance penetration capability. The IIR Maverick uses IR emissions from the target for lock-on and launch, making it suitable for use at night, under the weather, and in limited visibility. Target-recognition ranges with the IIR, day or night, are about twice the range of corresponding daylight visual recognition without it. Use of IIR from standoff range is effective against mobile armored targets such as tanks.	The IIR Maverick cannot *see* through clouds, precipitation, or fog.
55E Laser ck (LMAV) Marine Corps) nd A-6E, F/A-18, , and A-6 platforms odifications)	The LMAV follows laser-designator emissions. It is suitable for night and limited adverse weather operations when used with aircraft laser spot trackers. It employs a 125-pound warhead or 300-pound Maverick alternate warhead with a selectable-delay fuse.	The LMAV cannot *see* through clouds, precipitation, or fog.
55F Navy Maverick Marine Corps) latform	This model is used for attacks against ships or coastal targets. It has the same capabilities as the AGM-65D.	This model cannot *see* through clouds, precipitation, or fog.
0/12 Laser I Bomb (LGB) ck platforms	The bomb provides precision day/night attack capabilities.	The weapon cannot *see* through clouds, precipitation or fog. Target must be illuminated by a laser designator.
5 IR Guide Bomb rce) -111F, and F-15E ms	The bomb provides precision day/night attack capability. It can be delivered from medium to low altitude at standoff ranges, thus enhancing the survivability of the delivery aircraft.	The weapon cannot *see* through clouds, precipitation, or fog. It requires very high aircrew work load.
4 Low-Level Laser Bomb (LLLGB) 15E, F-16, F-111 ns	This bomb provides precise, stand-off day/night attack capabilities.	Its limitations are similar to other GBU weapons (GBU-10/12).

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APPENDIX F.

SOVIET GROUND-FORCE WEAPONS SYSTEMS

The following unclassified information regarding Soviet ground force night and adverse weather sighting mechanisms is from *Jane's Weapon Systems.*

The Soviets have developed and deployed a wide range of night-vision equipment for all types of equipment, ranging from rifles, machine guns, antitank launchers, and antitank guns to armored vehicles. Most of this equipment is active IR, although the APN-2 and NSP-2 can be both active and passive. The APN-2 is mounted on antitank guns and has a maximum range of 900 meters. The NSP-2 is mounted on weapons such as the AK-47 assault rifle and the RPG-2 antitank weapon.

The APN-3 and APN-57 IR sights are mounted on antitank guns. The APN-3 has a maximum range of 2,000 meters; the APN-57, 700 meters. The PPN-1 and PPN-2 IR sights are mounted on machine guns. The PPN-1 has a maximum range of 300 meters; the PPN-2, 500 meters.

The TVN-1 and TVN-2 IR driving aids are mounted on the glacis plates of main battle tanks such as the T-55. The drivers have monocular observation pieces on the TVN-1s and binocular pieces on the TVN-2s.

Night-vision equipment on the T-62 main battle tank includes an IR searchlight to the right of the main armament (maximum range of 800 meters), an IR spotlight on the commander's cupola (maximum range of 200 meters), and an IR driving light for the driver (maximum range of 60 meters). The T-64 and T-72 main battle tanks have passive night-vision equipment.

The 7.62-mm SVD semiautomatic sniper's rifle and some field binoculars also have IR detection systems.

The Soviets have been using both tripod- and vehicle-mounted laser range finders on their artillery for a number of years. One such laser system, the DAK-1, is battery-powered and usually tripod-mounted. It has a maximum range of 11 kilometers.

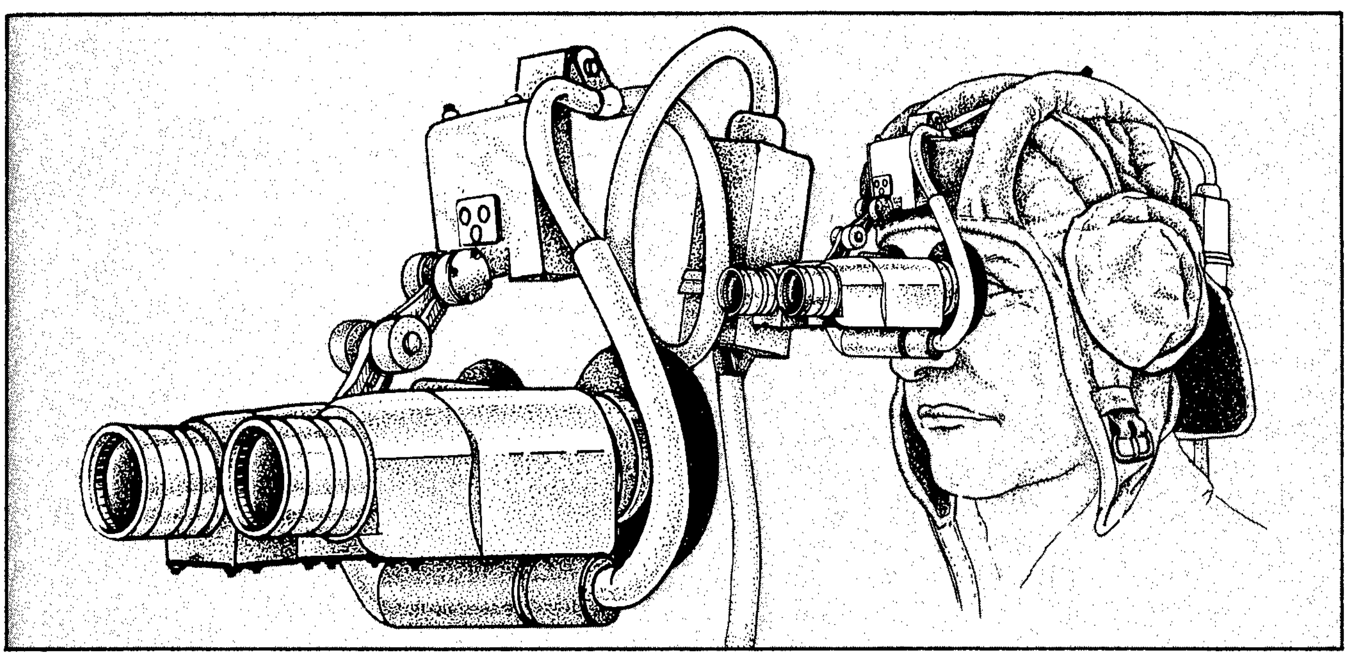

Figure F-1. PNV-57

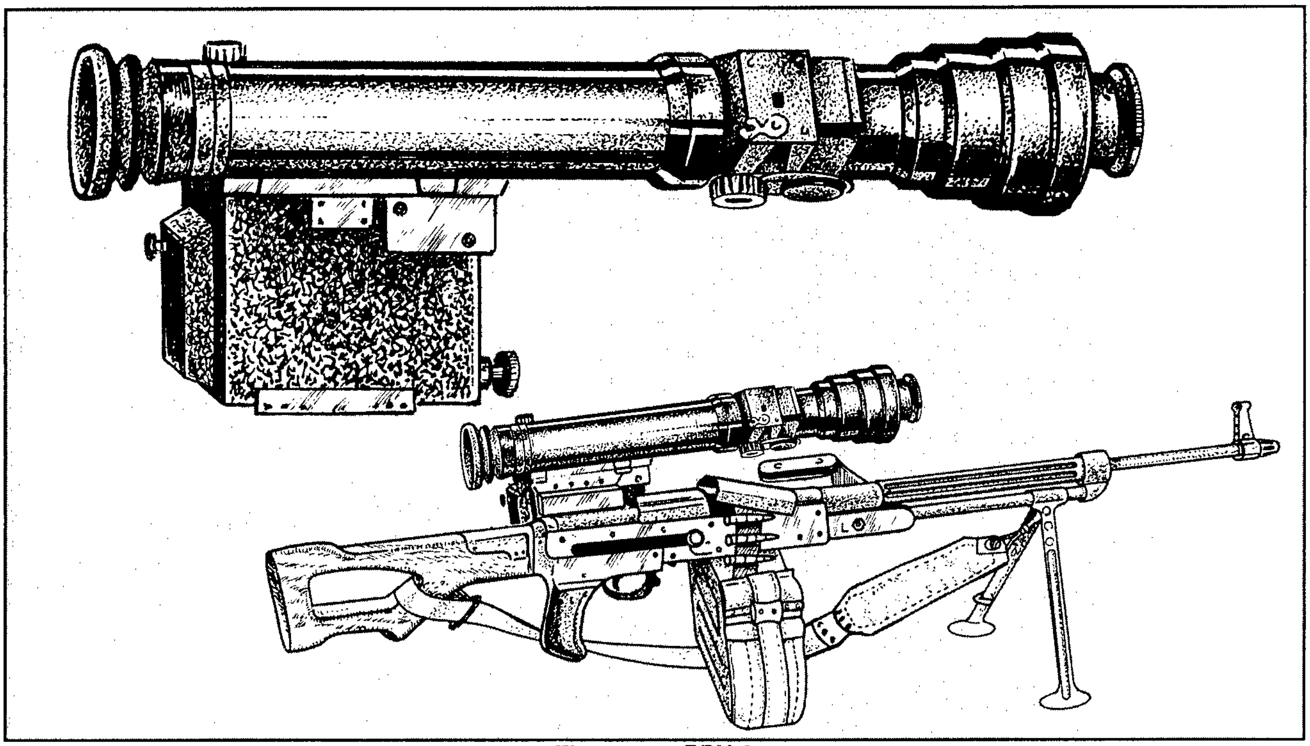

Figure F-2. PPN-3

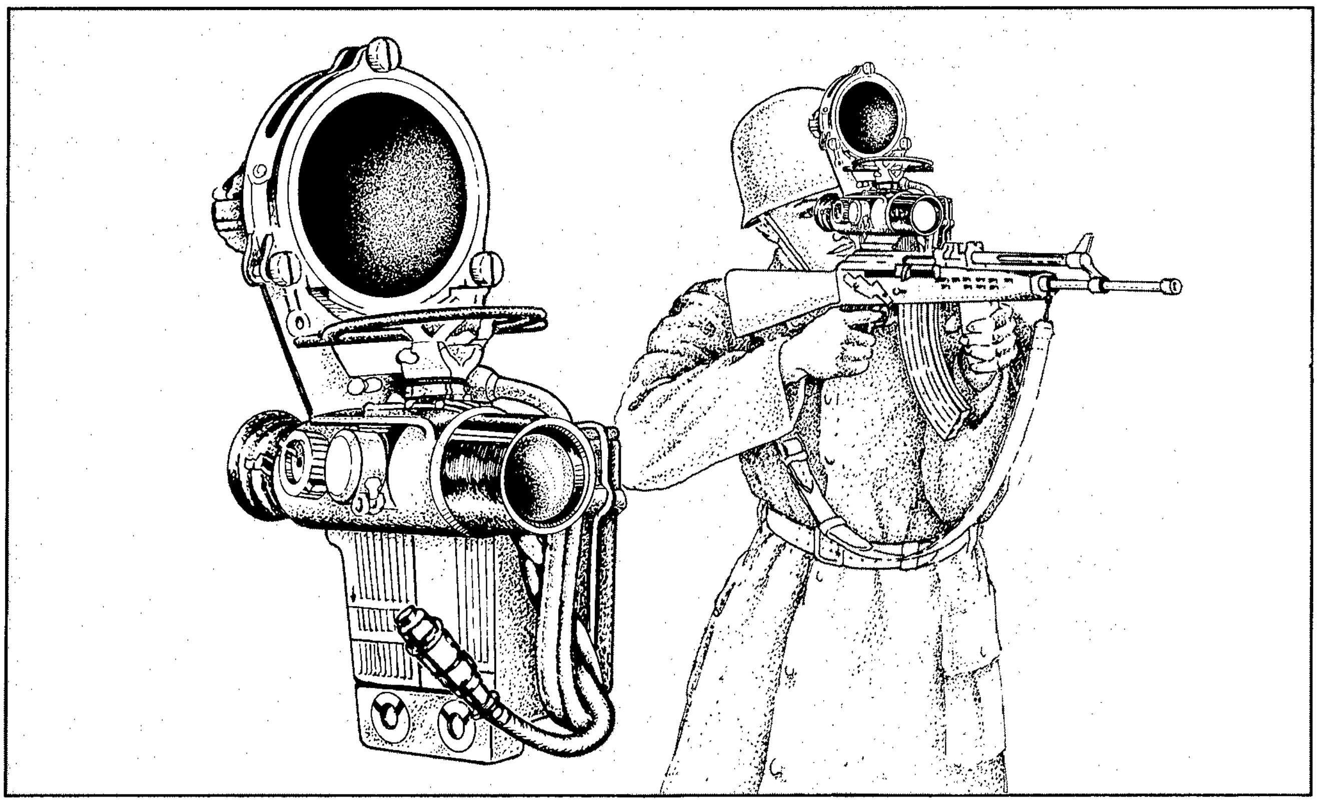

Figure F-3. NSP-2

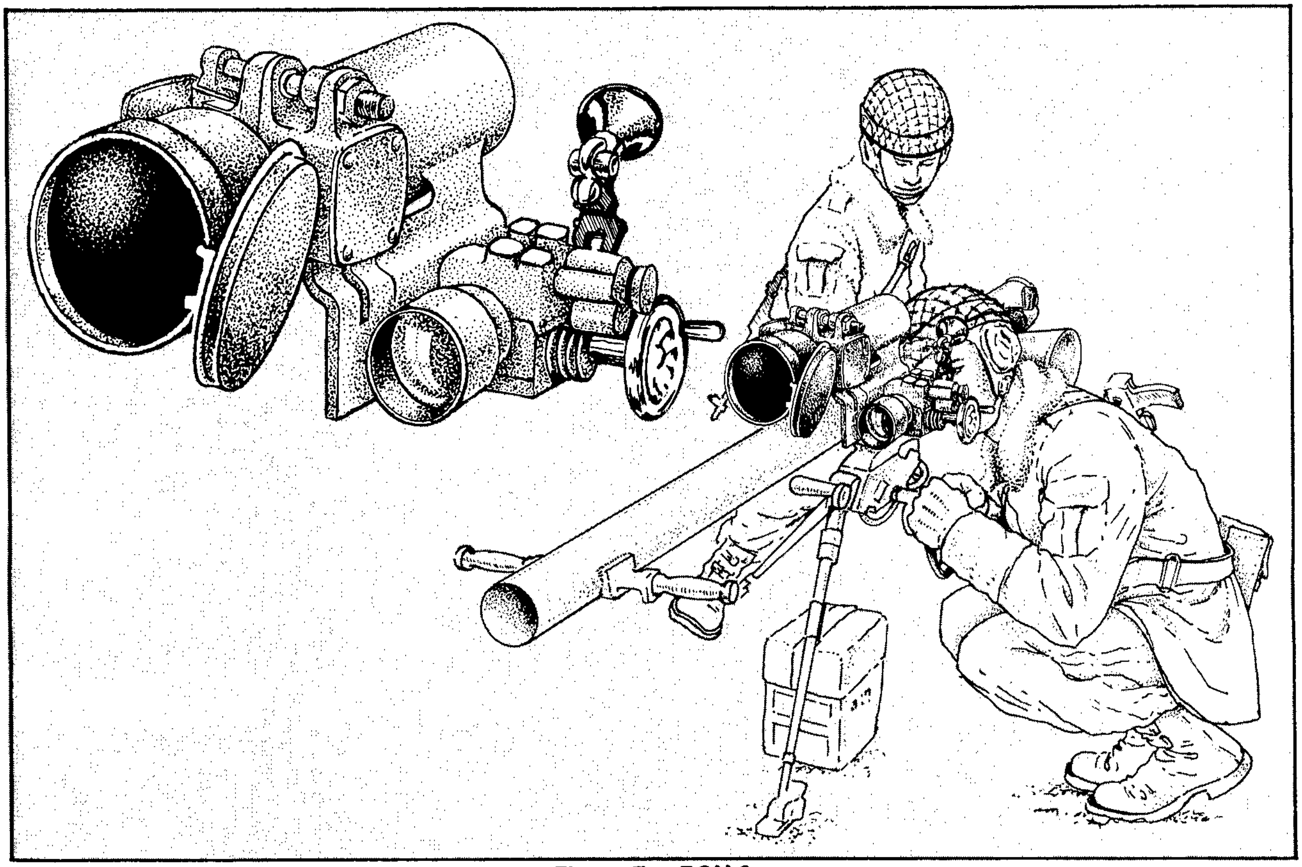

Figure F-4. PGN-9

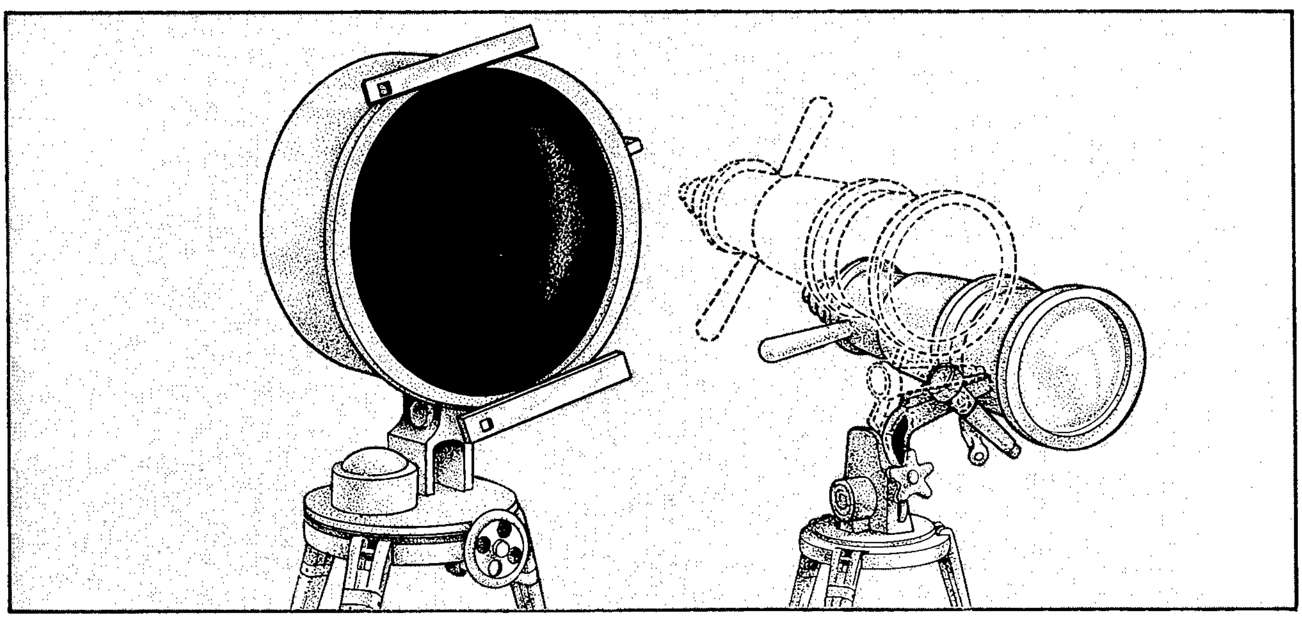

Figure F-5. IR Surveillance System

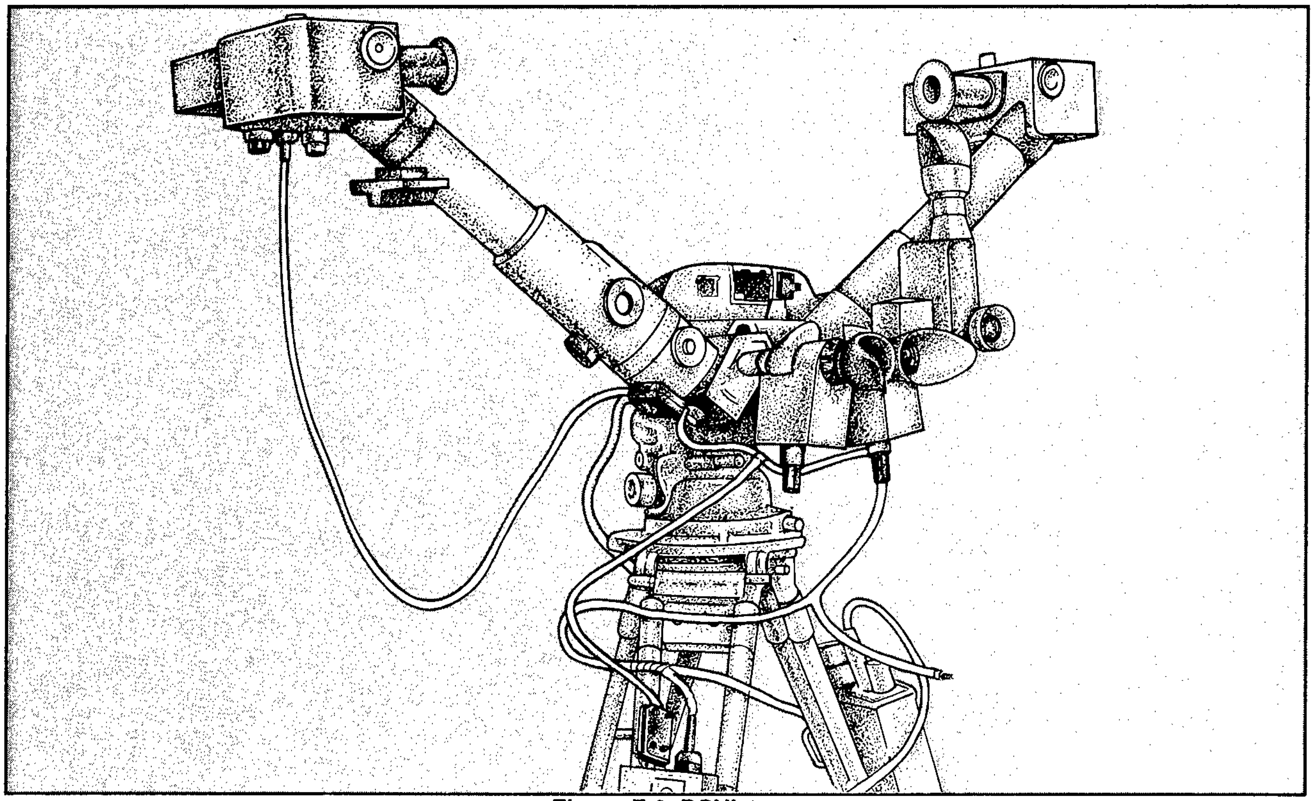

Figure F-6. DSNI-1

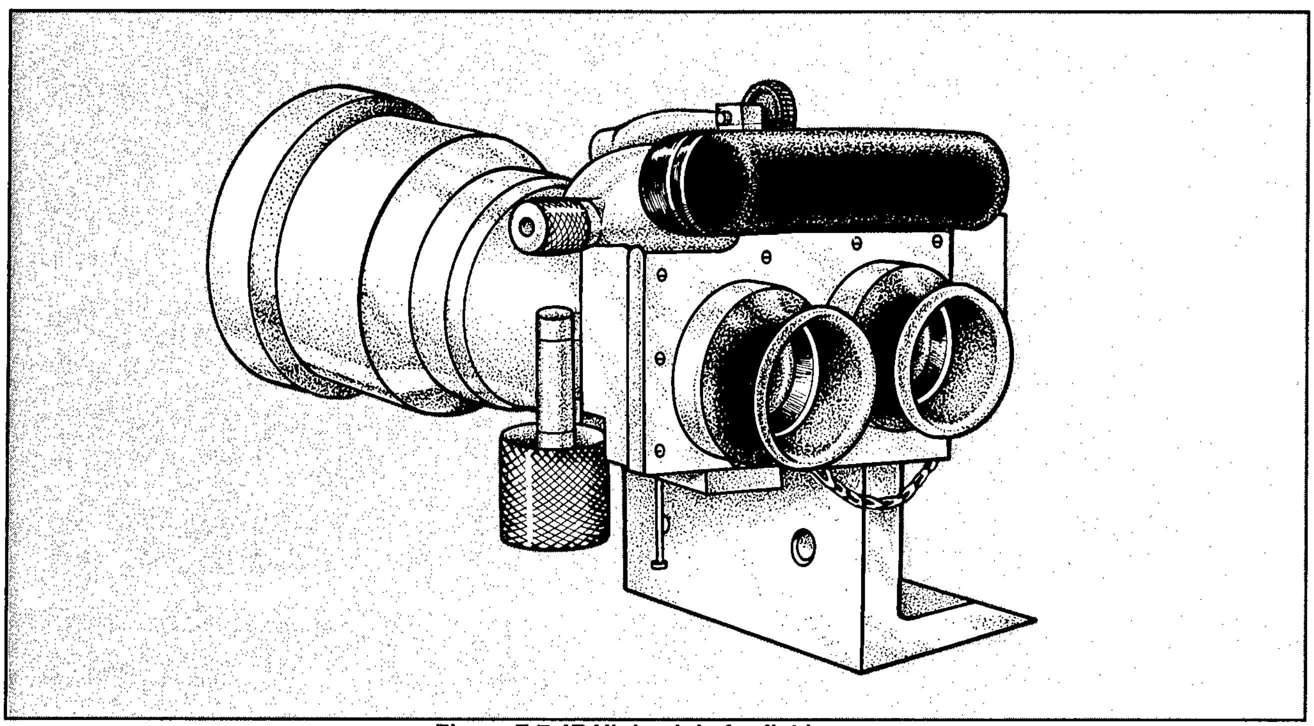

Figure F-7. IR Night sight for field guns

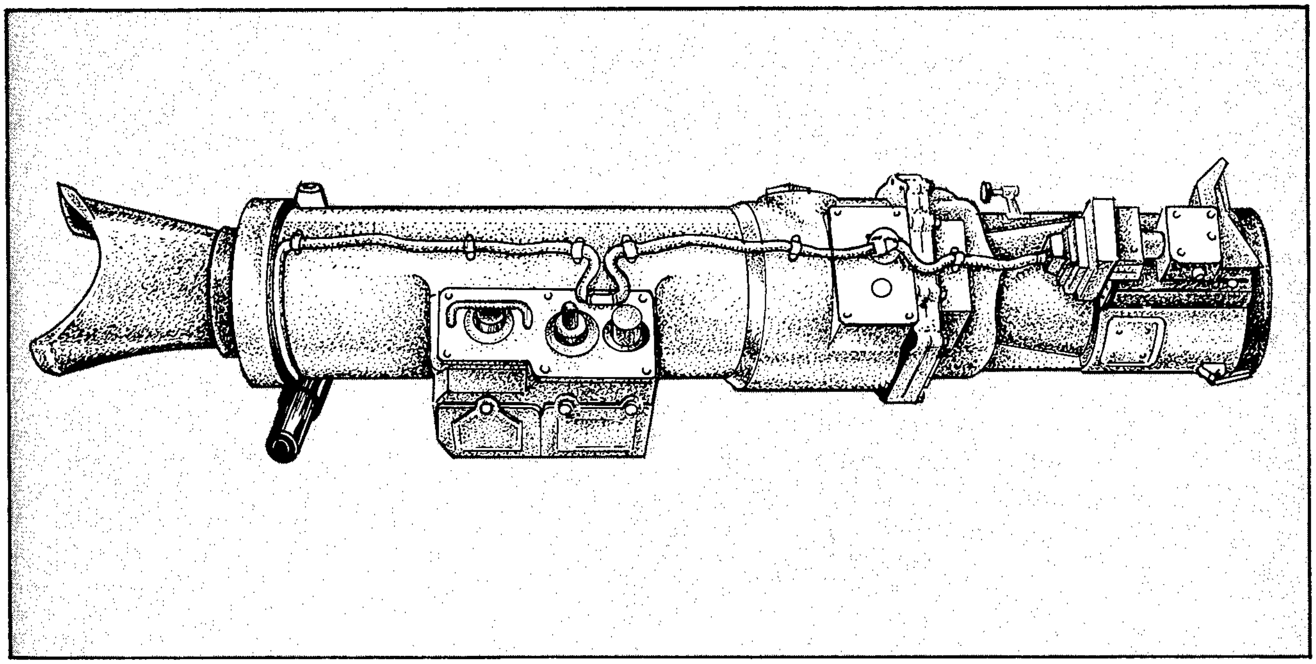

Figure F-8. APN 3-7

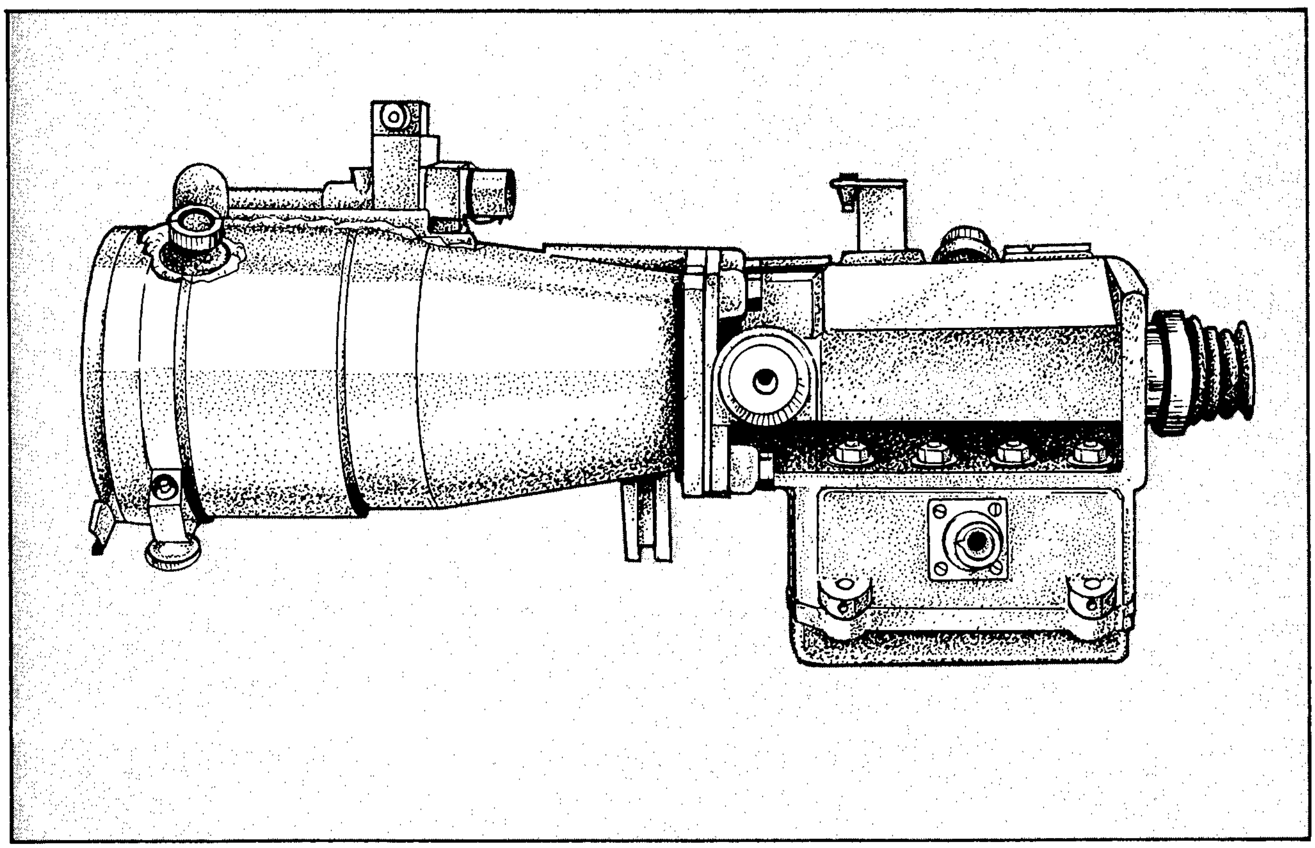

Figure F-9. NNP-20M

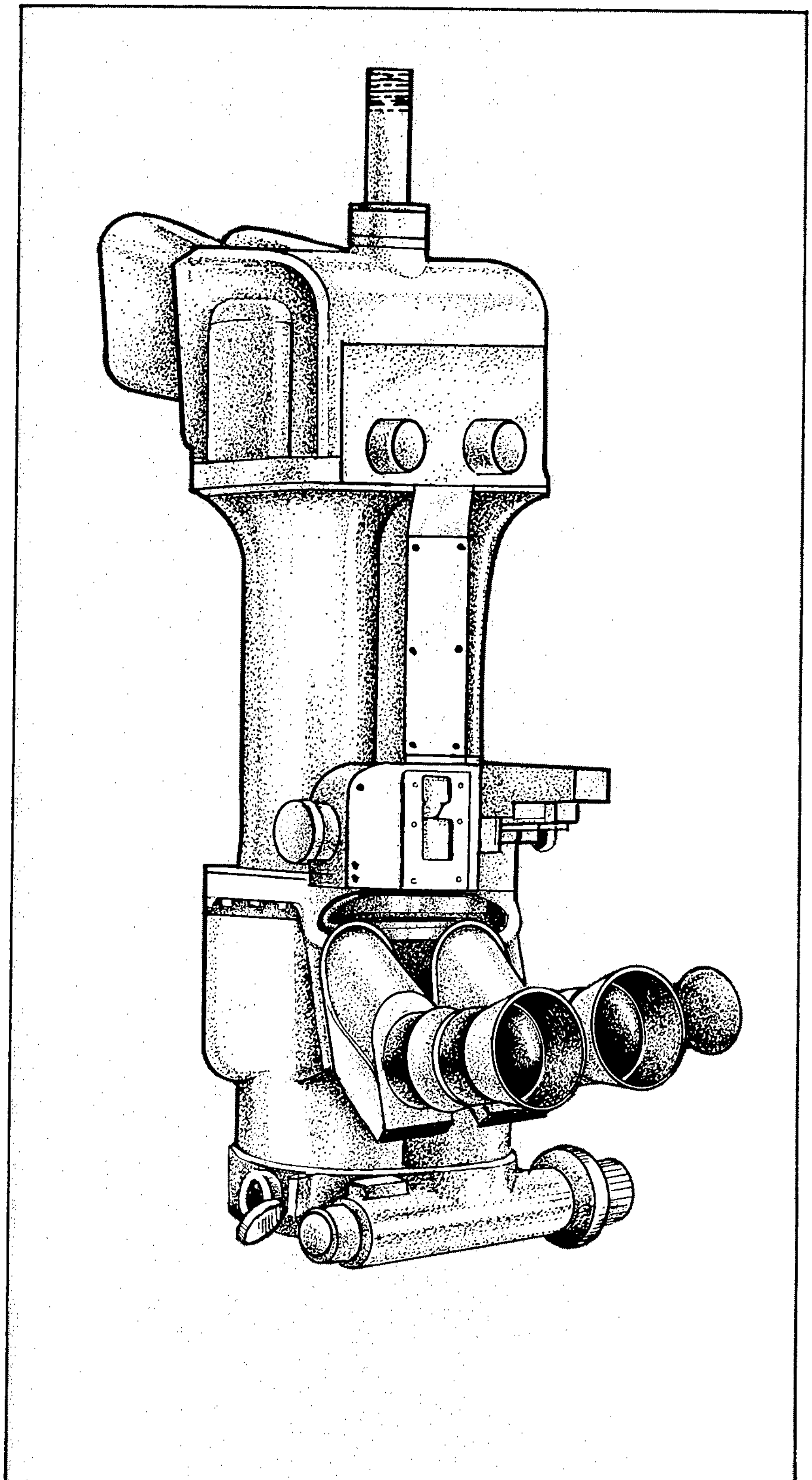

Figure F-10. RT-2 Reconnaissance Theadolite

APPENDIX G.

SOVIET AIRCRAFT AND WEAPONS SYSTEMS

The unclassified information in Table G-1 regarding Soviet aircraft capable of operating at night and during adverse weather conditions is taken from *Jane's All the World's Aircraft*.[1] Please note that all Soviet aircraft with an air-to-air mission are considered to possess night and adverse weather capabilities due to groundcontrolled intercept direction.

Table G-1. Soviet aircraft capabilities

TYPE	CAPABILITY
MiG-21, Fishbed	All-weather, air-to-air capabilities. Jaybird AI radar (search range of 10.8 NM).
MiG-23, Flogger	All-weather, air-to-air capable High Lark AI radar (search range of 46 NM, tracking range of 29 NM).
MiG-25, Foxbat	All-weather, air-to-air capable Fox Fire AI radar (search range of 45 NM).
MiG-29, Fulcrum	All-weather, air-to-air capable pulse Doppler radar.
Su-15, Flagon	All-weather, air-to-air capable Twin Scan AI radar.
Su-17,-20,-22, Fitter	All-weather, air-to-air capable High Fix AI radar.
Su-24, Fencer	All-weather, air-to-ground capable, having terrain-avoidance and navigation attack pulse Doppler-type radar.
Su-25, Frogfoot	All-weather, air-to-ground capable, having a full range of ground attack weapons.
Su-27, Flanker	All-weather, air-to-air capable, track-while-scan radar (search range of 130 NM, track range of 100 NM).

1 See MCM 3-1, *Tactical Employment Treat Guide and Countertactics* (S,NF), Volume II, for comprehensive classified information on Soviet aircraft and weapons systems.

Table G-1. Soviet aircraft capabilities (continued)

TYPE	CAPABILITY
Tu-16, Badger	All-weather, air-to-ground capable with radar assistance.
Tu-95, -142, Bear	All-weather, air-to-ground capable. Big Bulge radar for reconnaissance and potential target data (Bear-D). Short horn sector-scan navigation radar.
Tu-22, Blinder	Probable all-weather capability.
Tu-26 (Tu-22M) Backfire	All-weather, air-to-ground capable down beat bombing and navigation radar. Probable all-weather, air-to-ground capability.
Tu-28P, -128, Fiddler	All-weather, air-to-air capability.
Tu-160 Blackjack	Probable all-weather, air-to-ground strategic bomber.

APPENDIX H.

JOINT FORCES WEATHER SUPPORT

With more and more emphasis on joint combat operations, weather support must be at least a coordinated, if not integrated, effort between the weather units in the Air Force, Navy, and Marine Corps. Joint operations planning should address interoperability among these units to meet all operational support requirements.

Weather units provide support to commanders and their staffs. This support involves advice and decision assistance. The weather units present staff- and command-level briefings, prepare environmental annexes to plans and orders, and request or prepare climatological studies and analyses in support of planned operations. Although specific support products may differ, the support capabilities and limitations of all weather units are somewhat similar.

WEATHER FORECASTS

Observations

Capabilities

The foundation for all forecasting is based on observations--the accurate, detailed knowledge of the three-dimensional state of the atmosphere and oceans at a specific time. Most units can routinely take and disseminate standard surface observations. Some weather units have special equipment to observe and disseminate vertical profiles of certain atmospheric elements (winds, pressure, temperature, and moisture) and to receive radar information. Air Force special operations have dedicated weather teams with tactical elements that are capable of deploying into areas of operations to report observations and trend forecasts to Air Force special operations bases and detachments.

Meteorological polar-orbiting satellites can provide visual and IR observations at least twice daily. Mission sensors on Defense Meteorological Satellite Program satellites can also provide vertical temperature profiles and environmental space data. Only USAF units at the theater level and selected naval ships are capable of receiving satellite data directly and processing the data to enhance features on imagery or disseminating data. Weather satellite signals of several nations can be received on tactical terminals used by lower echelon weather teams. Environmental units at sea routinely take and disseminate ship weather observations. In addition to standard atmospheric parameters, these observations include such oceanographic information as sea surface temperature, wave periods and heights, and directions, periods, and heights of swell systems. The units also routinely record bathythermograph observations.

Meteorological and oceanographic observations can also come from--

- In-flight or post-flight pilot's reports from combat aircrews.
- Air Force combat control teams and air traffic control agencies.
- Unmanned-aerial vehicles' in-flight weather obscurants collected en route.
- Army artillery meteorological sections.
- Long-range surveillance units.
- Aviation and air traffic control units.
- Engineering and artillery survey units.
- Engineer topographic units.
- Ground reconnaissance elements.

- Brigade and battalion intelligence personnel under the Forward Area Limited Observation Program.
- Activities and units under Naval Oceanography Command control, such as the Ocean Development Squadron Eight and Military Sealift Command's oceanographic and hydrographic ships.
- Other ships, aircraft squadrons, and shore units to which no geographical personnel are assigned.
- Indigenous sources of observations.

Limitations

Forecast accuracy is directly related to the detail of available environmental data, the time of the forecast, the distance between observation points, the timeliness of the data, and the required time span of the forecast.

Generally, the more precise the definition of the environment, the more accurate the forecast. The degree of precision of most meteorological and oceanographic elements varies according to precision of the instruments and sensors used. For some of those elements that are difficult to observe or measure, mathematical algorithms can be applied to derive values. However, environmental data is not routinely available for open oceans and enemy-held or enemy-controlled territory.

Only meteorological satellites, weather radar, and special operations weather teams with tactical elements can provide observations from data-denied areas. Forecasts for these areas will be less accurate than for adequately observed areas.

The established observation network may be too sparse to provide an accurate forecast. Observation points 50 kilometers apart may not provide data detailed enough to define an environment where terrain significantly influences weather. For example, an observation on the windward side of a mountain will not be representative of conditions on the leeward side. Adequate resolution in such areas may require observation points no more than 10 kilometers apart.

Defining a current environment using old data can also lead to forecast inaccuracies. Since weather data is extremely perishable, especially in rapidly changing weather, observations several hours old may be useless. Highly responsive communications are important, especially during periods of approaching adverse weather. However, changes in the weather can generate peak loads on communications resources, and at those times, weather information is most urgent.

The longer the time span between the forecast valid time and the forecast issue time, the less accurate the forecast. The loss of accuracy is compounded if the forecast is detailed rather than general.

Current state-of-the-art forecasting made possible by computers doesn't always permit routine production of accurate, detailed operational forecasts. A time interval between forecasts of more than 48 hours may make that forecast invalid before a new forecast is issued. Even 3-5 day forecasts should be issued every 24-48 hours.

Climatology

Capabilities

Climatological information includes a history of average weather conditions and variations for a particular location during a specified period. Climatic summaries can be narrative or tabular statistics of weather elements in terms of averages, extremes, and frequencies of occurrence over a given period, at a given point, along a route, or within an area. Climatic studies are analyses and interpretations of climatic information which predict probable effects of the environment on a specific operation or activity. For example, climatic studies of wind chill factors can determine clothing requirements, seasonal heating and cooling requirements, and suitability of coastal areas for amphibious operations.

The Army uses climatological maps and displays of representative weather elements such as rainfall, snow depth, visibility, persistence of fog, cloud heights, and so forth as planning tools in the early intelligence preparation of the battlefield before deployment. The same products are later prepared in the theater based on each forecast.

The Naval Oceanographic Office conducts various oceanographic, geophysical, and acoustic surveys and maintains historical ocean data in its computer files. The files include bathythermograph data, data on surface and subsurface currents, seismic profiles, acoustic bottom-loss data, and coastal oceanographic surveys.

Limitations

The accuracy of climatic statistics depends upon the quality and quantity of the data from which they derive. Significant limitations of climatic information result from--

- An insufficient period of record or total number of observations of a particular element. In general, 10 years of data is desirable; 5 years is the minimum length of record that merits any degree of confidence.
- Inconsistency of recorded data due to instrumentation changes or malfunctions, instrumentation location, or station changes.
- Lack of nighttime data.
- Inadequate data on operationally significant weather elements such as winds aloft and cloud bases and tops.
- Lack of historical data for periods of less than a month.
- Outdated data that may not be representative of current climate conditions.
- Inadequate capability to provide information on areas between regular reporting station (spreading climatology techniques).

WEATHER SUPPORT SYSTEM

Forecasting Services

The weather support system primarily provides forecasts: operational support products and mission-tailored forecasts. Operational support products have a predetermined format to cover broad geographical areas, extended time spans, and multiple parameters. They are for general-purpose use. Mission-tailored forecasts are tailored to the mission being supported and formatted for direct use by the supported unit.

Forecasting services are generally at the echelon with the largest group of forecasters at the highest command element. At the joint headquarters, for example, a dedicated forecast unit, the Tactical Forecast Unit, Joint Forecast Control Agency, provides and disseminates operational support products applicable to the entire joint task force.

Weather units supporting subordinate joint task force units use these products to make their own mission-tailored forecasts tailored to their customers' specific requirements.

These products can come from units outside the joint task force, such as the Air Force Global Weather Central or the Fleet Numerical Oceanography Center, where data bases are more extensive. Operational support products can also be obtained from indigenous weather organizations. Forecasting services can include briefing aircrews during mission briefs or through pilot-to-metro-service radios, issuing warnings and advisories of hazardous weather, and monitoring the weather over the area of operations.

Weather Units

The Air Force weather units provide weather support for both the Army and the Air Force. The Air Weather Service can provide direct combat support through deployable weather teams to–

- Selected joint headquarters.
- Air Force units (wings, squadrons).
- Army units (echelons above corps, divisions, separate brigades, armored and theater aviation groups).
- Special operations units (joint headquarters, Air Force special operations base/detachment, Army special forces groups and battalions, and Army Ranger regiments located at special forces operating bases, and forward-operating bases).

Navy

The Naval Oceanography Command can provide direct weather support through shore and field activities, facilities, and detachments to combat naval resources ashore. Although not under the Naval Oceanography Command organizational or command structure, other Naval oceanographic and meteorological support-system units can provide direct support to joint headquarters, ships, and activities.

Marine Corps

Marine Corps aviation weather units provide direct combat support to the host aviation unit when deployed. Mobile meteorological facilities are normally deployed to support strategic expeditionary landing fields and air bases and vertical take-off and landing forward-operating sites for limited combat support. Other combat units requiring weather support are supported remotely.

New Programs

In addition to replacements for surface-observing and low-level wind-measuring equipment used to support Air Force and Army tactical operations, two new programs will directly enhance weather support to combat operations.

The Automated Weather Distribution System, as well as its deployable version, the Transportable Automated Weather Distribution System, consists of a network of minicomputers, communications interfaces, and display devices. The system is designed to upgrade on-base processing and interbase and intrabase distribution of weather information. The transportable system is scheduled for initial operational capability in FY 92.

The Battlefield Weather Observation and Forecast System has two separate but complementary functions. The first function is to obtain weather observations from enemy-controlled and data-denied areas. Its prestrike surveillance and reconnaissance system uses sensor packages aboard unmanned air vehicles and meteorological satellites to do this. The second function is to prepare and distribute tactical decision aids.

A tactical decision aid is a product which assists tactical decision makers to understand factors impacting threat and friendly weapons systems, operations, tactics, equipment, and personnel and to use that knowledge for tactical advantage. It may be a weather briefing chart or the output of a computer model. The objective of the computer model is to predict the performance of E-O PGMs or TADs that function in the visible, IR (including laser), and millimeter wavelengths. Inputs for these computer models are–

- Weapons-specific sensor information.
- Target and background information.
- Weather observations (including prestrike surveillance and reconnaissance system data).
- Weather forecasts.

Examples of resulting tactical decision aids include target-acquisition range, lock-on range, and target-background contrast and polarity. Initial operational capability for this system is scheduled for FY 93. Weather teams have the capability to issue selected tactical decision aids now.

Ongoing Program

The Integrated Refractive Effects Prediction System is an operational US Navy software system which uses on-scene refractivity data and electromagnetic system parameters to assess the performance of electromagnetic systems under various atmospheric conditions. It provides both general and radar-specific propagation conditions which can be used--

- To minimize aircraft detectability on tactical penetration missions by predicting the altitudes where ducts or holes exist in radar coverage and estimating the maximum range.
- To position aircraft to maximize UHF communication range, minimize aircraft radar broadcast distance, find optimum altitude for antielectronic warfare aircraft, and maximize effectiveness of jammers.
- To determine the capabilities of friendly radars allowing for compensatory measures to be taken, that is, using airborne radar systems.

The system is limited because it is valid only for radar and communications systems operating in the 100 megahertz to 20 gigahertz range, including UHF and microwave. It is not valid for HF communications. Also, while it is valid for over-water range, for example, penetration of coastal radars, the physics of the model limits its over-land application.

MAC applications include tactical penetration of coastal radars, UHF communications, and other special operations missions.

APPENDIX I.

GLOBAL POSITIONING SYSTEM

Global Positioning System (GPS) is a space-based, worldwide navigation, positioning and timing system. The Department of Defense and Department of Transportation have agreed that GPS will replace the tactical navigation, long-range navigation, Omega, VHF Omni Range, distance measuring equipment and transit systems. GPS provides three dimensional position accuracy of 16 meters, velocity accuracy of 0.1 meters per second and time to within 100 nanoseconds. GPS also provides a worldwide continuous time sync to communications systems.

GPS is passive. It does not require interrogation nor is it encrypted. Only those with the crypto keys can receive the precision accuracy code. A receiver evaluates all the satellites it can see, selects the four best and then solves for the four unknowns of latitude, longitude, altitude/elevation, and time. The number of channels relates to the number of satellites that can be tracked simultaneously. More channels mean faster position updates.

GPS SEGMENTS

GPS has three segments: space, control, and user.

The space segment is composed of satellites that transmit navigation messages. The operational satellite constellation will have 24 satellites at an altitude of 10,900 nautical miles. This ensures at least five satellites are visible to a receiver anywhere on the earth.

The control segment, managed by the Air Force Space Command, is a network of ground facilities that monitor the satellites and maintain the system. The master control station is at Falcon Air Force Station, CO, with related facilities on the islands of Hawaii, Ascension, Diego Garcia, and Kwajalein. This segment is operational now.

The user segment consists of the satellite receivers. Presently, three types of receivers are in production for the Department of Defense:

- A one-channel set for low dynamic users, such as people and surface vehicles.
- A two-channel set for medium dynamic users, such as helicopters.
- A five-channel set for high dynamic users, such as aircraft, submarines, and big surface ships.

The one-channel manpack weighs 17 pounds with battery. The battery is a throw-away lithium in the manpack configuration and a rechargeable nickle-cadmium in the manpack/vehicle configuration. The manpack consists of the receiver and a control display unit attached by a cable. The manpack/vehicle version has an additional vehicle power adapter that connects to the vehicle battery to charge the battery and power the set. Data entry and displays can be in US or metric system measures and Air Force or Army measures to include–

- Latitude/longitude.
- Mercator Grid Reference System.
- Universal Transverse Mercator/Universal Polar System.
- 47 Datum.

Locations are displayed to tenths of seconds, thousandths of minutes, or one-meter square with elevation to the nearest foot or meter. It provides bearing and distance to a point; velocity and heading from the operator's position, heading corrections to a course, estimated position error, set status, and so forth.

The Tactical Air Forces are scheduled to get over 1000 one-channel sets. Installation is designed for rapid field removal to use as a basic manpack. The manpack/vehicle version has an interface to the RF oscillator in the GRC-206 to provide time of day to the Have Quick UHF radio.

The Army will get over 15,000 one-channel sets. For the artillery, the manpack/vehicle version will be integrated with the Position and Azimuth Determining System. At division and below, the system will be assigned to light and heavy divisions, signal and combat electronic warfare and intelligence battalions, cannons, multiple-launch rocket systems, and remotely piloted vehicle batteries. At echelons above division, GPS will be assigned to Special Forces, Rangers, Pathfinders, signal units, combat electronic warfare and intelligence groups, artillery units, transportation units, and Patriot air defense battalions.

The Navy and Marine Corps are also procuring GPS receivers.

The two-channel set consists of the receiver, fixed reception pattern antenna, antenna electronics unit, and control display unit. It will be installed in helicopters as a stand-alone sensor or integrated with inertial navigation system or Doppler systems. GPS can provide navigation--rendezvous to a moving way point, airborne instrument approach with glide slope, and data loader interface. The Army will get over 5000 sets.

The five-channel set consists of the receiver, null steering antenna, and antenna electronics unit. All US Air Force aircraft will get a five-channel set. It can be installed as a stand-alone sensor or integrated with existing navigation sensors. The system can provide--

- Navigation.
- Level and loft weapons delivery.
- Target acquisition assistance.
- In-flight INS alignment.
- Rendezvous to a moving way point.
- Time sync to Have Quick.
- Airborne instrument approach with glide slope.
- Flight instrument interface.

GPS EMPLOYMENT ON THE AIRLAND BATTLEFIELD

Tactical Air Control Parties will use GPS for overland navigation, self-positioning, Have Quick time source and, most importantly, target location computation. The air liaison officer can enter his estimate of range, azimuth, and elevation angle to a target into the receiver. Since the set knows its own position, it can then compute and display the targets horizontal coordinates and elevation. Mobile radar units will use GPS to navigate to remote sites, position radars and long-haul communications, and provide a back-up time of day source for Have Quick radios.

Army field artillery will use GPS to navigate overland, to anchor the position and azimuth determining system, and to position multiple-launch rocket systems and remotely piloted vehicles. Signal units will use GPS to anchor the Position-Location Reporting System master and relay stations. Combat electronic warfare and intelligence units will use it for navigation and positioning voice, communication, and electronic collection assets. Maneuver units will benefit from faster mission planning and mission execution during overland navigation. GPS will position air defense artillery fire units and radars. Watercraft units will use GPS for harbor entry, inland/coastal navigation, and amphibious landings.

Army fixed-wing aircraft and helicopters will use GPS in tactical and tactical support missions. GPS will provide precise navigation through corridors, to resupply points, instrument approach to remote landing zones, and accurate positioning of in-flight collection assets.

All members of the joint air attack team should benefit from more accurate locations of threats, targets, and friendly forces.

Any GPS fighter can deliver weapons to support ground forces even in conditions that prohibit visual target acquisition by the fighter pilot. Target acquisition by aircraft sensors is not required. GPS can eliminate the current need for target illumination and the resulting alert to target defenses. GPS does not compete with visual weapon deliveries; rather, it reduces the need to see in night and in adverse weather.

Any nonradar aircraft with GPS can possess an all-weather, level and loft, blind bombing accuracy better than today's F-16 radar offset delivery accuracy. In the 1985 developmental and operational tests, a GPS equipped F-16A consistently blind bombed on coordinates 50 percent better than the plain vanilla F-16 did using radar. Once operational experience is gained, a GPS equipped ALO coupled with a GPS equipped fighter should be able to employ coordinate bombing on some CAS targets. Additionally, GPS can provide course and glide path displays for instrument recoveries to forward operating locations that have no navigational aids or main operating bases with navigational aids shut down.

Improved technology has made GPS man-portable receivers smaller and lighter. Most are commercial sets although some are built to military specifications. In April 1989, the Joint Program Office for GPS awarded a contract for the small lightweight GPS receiver. Its specifications call for a 5-pound, hand-held set built to commercial specifications. The accuracy requirement has been raised to 50 meters and it has no antijamming capability.

GPS can provide a significant increase in all-weather, round the clock air support to ground forces. Since all services will use GPS, there will be a common grid and time reference across the air, land, and sea battlefields.

GLOSSARY

AAA
antiaircraft artillery

ADSS
ANVIS display symbology system

adverse weather
Weather in which military operations are generally restricted or impeded. (JCS Publication 1-02)

aerosol
Small particles suspended in the air. Haze, smoke, and some small fog/cloud droplets are examples of aerosols. (AWS/TR-79/002)

AFAC
airborne forward air controller

AFB
Air Force base

AFM
Air Force manual

AFR
Air Force regulation

AGL
above ground level

air defense suppression
In air operations, actions taken to degrade fixed and mobile surface-based component of enemy air defense systems so that offensive air forces may effectively attack a target. (JCS Publication 1-02)

air interdiction
Air operations conducted to destroy, neutralize, or delay the enemy's military potential before it can be brought to bear effectively against friendly forces at such distance from friendly forces that detailed integration of each air mission with fire and movement of friendly forces is not required. (JCS Publication 1-02)

air reconnaissance
The collection of information of intelligence interest either by visual observation from the air or through the use of airborne sensors. (JCS Publication 1-02)

air support radar team
A subordinate operational component of a tactical air control system which provides ground-controlled precision flight guidance and weapons release. (JCS Publication 1-02)

ALFA
Air Land Forces Application

ALO
air liaison officer

AM
amplitude modulation

antiair warfare
A US Navy/US Marine Corps term used to indicate that action required to destroy or reduce to an acceptable level the enemy air and missile threat (JCS Publication 1-02)

ANVIS
aviator's night-vision imaging system

ASRT
air support radar team

ATF
automatic terrain following

ATP
allied tactical publication

attn
attention

AWADS
adverse weather aerial delivery system

AWS
Air Weather Service

AWSR
Air Weather Service regulation

Bathythermograph
An instrument designed to record water temperature as a function of depth. (Webster's ninth New Collegiate Dictionary)

battlefield illumination
The lighting of a battle area by artificial light either visible or invisible to the naked eye. (JCS Publication 1-02)

beach marker
A sign or device used to identify a beach or certain activities thereon, for incoming waterborne traffic. Markers may be panels, lights, buoys, or electronic devices. (JCS Publication 1-02)

beginning-of-morning civil twilight
The time when the center of the sun is 6 degrees below the sea-level horizon and when adequate light exists for large scale military operation. (FM 34-81)

bioluminescence
The emission of light from living organisms. (Webster's Ninth New Collegiate Dictionary)

BMP
Infantry fighting vehicle (Soviet)

C
confidential (classification)

CAS
close air support

campaign plan
A plan for a series of related military operations aimed to accomplish a common objective, normally within a given time and space. (JCS Publication 102)

capability
The ability to execute a specified course of action (a capability may or may not be accompanied by an intention).

CINCLANTFLT
Commander in Chief, US Atlantic Fleet

close air support
Air action against hostile targets which are in close proximity to friendly forces and which require detailed integration of each air mission with the fire and movement of those forces. Also called CAS. (JCS Publication 1-02)

combined arms team
Two or more arms mutually supporting one another. A team usually consists of tanks, infantry, cavalry, aviation, field artillery, and engineers. (FM101-5-1)

COMNAVSURFLANTINST
Commander, Navy Surface Atlantic Instruction

COMNAVSURFPAC
Commander, Navy Surface Force Pacific

cm
centimeters

counterair
A United States Air Force term for air operations conducted to attain and maintain a desired degree of air superiority by the destruction or neutralization of enemy forces. Both air offensive and air defensive actions are involved. The former range throughout enemy territory and are generally conducted at the initiative of the friendly forces. The latter are conducted near or over friendly territory and are generally reactive to the initiative of the enemy air forces.(JCS Publication 1-02)

counterterrorism
Offensive measures taken by civilian and military agencies of the government to prevent, deter, and respond to terrorism. [The primary mission of SOF in this interagency activity is to apply specialized capabilities to preclude, preempt, and resolve terrorist incidents abroad.]

CSAR
combat search and rescue

CSS
combat service support

D-day
The unnamed day on which a particular operation commences or is to commence.... (JCS Publication 1-02)

DOD
Department of Defense

direct action missions
Direct action operations are short-duration strikes and other small scale offensive actions by SOF to seize, destroy, or inflict damage on a specified target; or to destroy, capture, or recover designated personnel or material. In the conduct of these operations, SOF may employ raid, ambush, or direct assault tactics; emplace mines and other munitions; conduct standoff attacks by fire from air, ground, or maritime platforms; provide terminal guidance for precision guided munitions; and conduct independent sabotage.

ECCM
electronic counter-countermeasures

ECM
electronic counter measures

electro-optics
The technology associated with those components, devices and systems which are designed to interact between the electromagnetic (optical) and the electric (electronic) state.

end-of-evening civil twilight
The time when the center of the sun is 620 degrees below the sea level horizon and when adequate light no longer exists for large scale military operations (FM 34-81)

E-O
electro-optical

ETAC
enlisted terminal attack controller

EW
electronic warfare

FAC
forward air controller

FARRP
forward area rearming/refueling point

flight following
The task of maintaining contact with specified aircraft for the purpose of determining enroute progress and/or flight termination. (JCS Publication 1-02)

FLIR
forward-looking infrared

FLOT
forward line of own troops

FM
frequency modulated; field manual

FMFRP
Fleet Marine Force Reference Pamphlet

FO
forward observer

FOV
field of view

FSO
fire support officer

FY
fiscal year

g
(acceleration of) gravity

GBU
glide bomb unit

GPS
global positioning system

GSR
ground-surveillance radar

G/VLLD
ground/vehicle laser locator-designator

HEI
high explosive incendiary

HF
high frequency

H-hour
The specific hour on D-day at which a particular operation commences.... (JCS Publication 1-02)

high threat
The surface-to-air high threat arena consists of radar guided antiaircraft artillery and/or radar guided SAMs and/or enemy air counter air threat. (MCM 3-1)

HQ
headquarters

HUD
heads up display

hydrography
The science which deals with the measurements and description of the physical features of the oceans, seas, lakes, rivers and their adjoining coastal areas, with particular reference to their use for navigational purposes. (JCS Publication 1-02)

ICM
improved conventional munitions

IEW
intelligence and electronic warfare

IIR
imaging infared

ILS
instrument landing system

IMC
instrument meteorological conditions

infrared radiation
Radiation emitted or reflected in the infrared portion of the electromagnetic spectrum. (JCS Publication 1-02)

INS
inertial navigation system

IR
infrared

IRC
infrared countermeasures

JCS
Joint Chiefs of Staff

JFACC
joint force air component commander

J-LASER
joint laser designation procedures

Joint Force
A general term applied to a force which is composed of significant elements of the Army the Navy or the Marine Corps, and the Air Force, or two or more of these Services, operating under a single commander authorized to exercise unified command or operational control over joint forces. (JCS Publication 1-02)

joint-force air component commander
The joint force air component commander derives his authority from the joint force commander who has the authority to exercise operational control, assign missions, direct coordination among his subordinate commanders, redirect and organize his forces to ensure unity of effort in the accomplishment of his overall

mission. The joint force commander will normally designate a joint force air component commander. The joint force air component commander's responsibilities will be assigned by the joint force commander (normally these would include, but not be limited to, planning, coordination, allocation and tasking based on the joint force commander;s apportionment decision). Using the joint force commander's guidance and other assigned or supporting commander's inputs, the joint force air component commander will recommend to the joint force commander apportionment of air sorties to various missions or geographic areas. (JCS Publication 1-02)

joint task force
A force composed of assigned or attached elements of the Army, the Navy or the Marine Corps, and the Air Force, or two or more of these Services, which is constituted and so designated by the Secretary of Defense or by the commander of a unified command, a specified command, or an existing joint task force. (JCS Publication 1-02)

JTF
joint task force

KIAS
knots indicated airspeed

LANA
low altitude night attack

LANTFLT
US Atlantic Fleet

LANTIRN
low-altitude navigation, targeting IR night

lb
pound(s)

LFRU
landing force reconnaissance unit

LGB
laser guided bomb

littoral current
Current moving generally parallel to and adjacent to the shoreline. (COMNAVSURFPAC/COMNAVSURFLANTINST 3840.1A)

LLLGB
low-level laser-guided bomb

LLLTV
low-level light TV

LMAV
laser Maverick

LOD
line of departure

LORAN
long-range navigation

LOS
line of sight

low threat
The surface-to-air low threat arena consists of small arms, optical antiaircraft artillery, possible SA-7, and limited enemy counter air. (MCM 3-1)

LST
laser spot tracker

LTD
laser target designator

m
meter(s)

MAC
Military Airlift Command

MACP
Military Airlift Command pamphlet

MACR
Military Airlift Command regulation

marginal weather
Weather which is sufficiently adverse to a military operation so as to require the imposition of procedural limitations. (JCS Publication 1-02)

maritime operation
An action performed by forces on, under, or over the sea to gain or exploit control of the sea or to deny its use to the enemy. (JCS Publication 1-02)

Maverick
An air-to-surface missile with launch and leave capability. It is designed for use against stationary or moving small, hard targets such as tanks, armored vehicles, and field fortifications. (JCS Publication 1-02)

MCM
multicommand manual

MDS
mission design series

Met
meteorological

Military Airlift Command
The single manager operating agency for designated airlift service. Also referred to as MAC. (JCS Publication 1-02)

mm
millimeter(s)

MMS
mast-mounted sight

mph
miles per hour

NAVAIR
navigational air

naval campaign
An operation or a connected series of operations conducted essentially by naval forces including all surface, subsurface, air and amphibious troops, for the purpose of gaining, extending, or maintaining control of the sea. (JCS Publication 1-02)

NAVENVPREDRSCHFAC
Naval environmental prediction research facility

NAVOCEANCOMINST
Naval Ocean Command instruction

NBC
nuclear, biological, chemical

NC
NOCONTRACT (not releasable to contractors consultants) [warning notice]

NF
NOFORN (not releasable to foreign nationals) [warning notice]

night
The period from end-of-evening civil twilight to beginning-of-morning civil twilight. (FM 34-81)

NM
nautical miles

NOC
Naval Oceanography Command

NOD
night-observation device

NOS
night observation system

NVD
night-vision device

NVG
night-vision goggles

NVS
night- vision system

NWP
Naval war pamphlet

OAS
offensive air support

obscurant
Man-made or naturally occurring gaseous, liquid, or solid particle suspension in the atmosphere which attenuates any portion of the electromagnetic spectrum.

OCA
offensive counterair

OH
operational handbook

OPR
office of primary responsibility

OSP
operational support product

PACAF
Pacific Air Forces

PACAFP
Pacific Air Forces pamphlet

pam
pamphlet

PAR
pararescue

pararescue
Specially trained forces who penetrate a search and rescue objective area by air, sea, or land to search for, contact and authenticate, secure, medically treat, assist in survival and evasion, and move personnel or material to locations suitable for subsequent rescue and recovery. Also paraescue team (PRT) or pararescue element (PRE).(USAF)

PGM
precision-guided munition

PLRS
position-location reporting system

PNVS
pilot night-vision sensor

PRE
pararescue element

precision-guided munition
A PGM is a missile, bomb, or artillery shell munition equipped with a terminal guidance system to enhance the PGM's ability to hit a target (AWS TR 79/002).

PROPIN
Caution--Proprietary information involved [warning notice]

PRT
pararescue team

RABFAC
radar beacon forward air controller

radar beacon
A receiver-transmitter combination which sends out a coded signal when triggered by the proper type of pulse, enabling determination of range and bearing information by the interrogating station or aircraft. (JCS Publication 1-02)

RB
radar beacon

REMS
remotely emplaced sensors

RF
radio frequency

RPM
revolutions per minute

RPV
remotely piloted vehicle

RSTA
reconnaissance, surveillance, and target acquisition

S
secret [clearance classification]

SAC
Strategic Air Command

SACP
Strategic Air Command pamphlet

SACR
Strategic Air Command regulation

SAM
surface-to-air missile

SAR
search and rescue

SATCOM
satellite communications

scheme of maneuver
The tactical plan to be executed by a force in order to seize assigned objectives. (JCS Publication 1-02)

sea, air, land team
A group of officers and enlisted personnel specially trained and equipped for conducting unconventional and paramilitary operations and to train personnel of allied nations in such operations including surveillance and reconnaissance in and from restricted waters, rivers, and coastal areas. Commonly referred to as SEAL team. (JCS Publication 1-02)

SEAL
sea, air, land (team)

SHORAD
short-range air defense

SKE
station-keeping equipment

SOF
special operations force

special operations
Actions conducted by specially organized, trained and equipped military and paramilitary forces to achieve military, political, economic, or psychological objectives by nonconventional military means in hostile, denied, or politically sensitive areas. These operations are conducted in peace, conflict, and war. Often of a politico-military nature, they may be conducted independently or in coordination with other military operations and may either support or be supported by conventional forces. Frequently of high-risk, they may be clandestine, covert or low visibility and may be subject to oversight at the national level. Special operations usually differ from conventional operations in operational techniques, mode of employment, distance from friendly support, and dependence upon operational intelligence and indigenous assets.

special reconnaissance
Reconnaissance and surveillance actions conducted by SOF to obtain or verify, by visual observation or other collection methods, information concerning the capabilities, intentions, and activities of an actual or potential enemy, or to secure data concerning the meteorological, hydrographic, or geographic characteristics of a particular area. It includes target acquisition, area assessment, and post-strike reconnaissance.

specs
specifications

storm surge
An abnormal rise of the sea along a shore as a result, primarily, of the winds of a storm. (Glossary of Meteorology)

strike
An attack which is intended to inflict damage on, seize, or destroy an objective. (JCS Publication 1-02)

TAC
Tactical Air Command

TACAIR
tactical air

TACAN
tactical air navigation

TACP
Tactical Air Command pamphlet/Tactical Air Control Party

tactical air support
Air operations carried out in coordination with surface forces and which directly assist land or maritime operations. (JCS Publication 1-02)

TADS
target-acquisition designation sight

TC
training circular

TFR
terrain following radar

TF/TA
terrain-following/terrain-avoidance

TIP
tactical information pamphlet

TOW
tube-launched, optically tracked, wire-guided (antitank missile)

TR
training regulation

TRADOC
US Army Training and Doctrine Command

TRAM
targrt recognition attack multisensors

TV
television

TVO
television optical

U
unclassified [clearance classification]

UAV
unmanned aerial vehicle

UHF
ultrahigh frequency

um
micrometer(s)

unconventional warfare
A broad spectrum of military and paramilitary warfare (UW)operations, normally of long duration, predominantly conducted by indigenous or surrogate forces who are organized, trained, equipped, supported, and directed in varying degrees by an external source. It includes guerilla warfare and other direct offensive, low visibility, covert, or clandestine operations, as well as the indirect activities of subversion, sabotage, intelligence collection, and evasion and escape.

US
United States

USA
United States Army

USAF
US Air Force

USAFE
US Air Forces Europe

USAFEP
US Air Forces Europe pamphlet

USMC
US Marine Corps

USREDCOM
United States Readiness Command

USSR
Union of Soviet Socialist Republic

USTRANSCOM
US Transportation Command

UW
unconventional warfare

VDV
airborne (Soviet)

VE
velocity

VHF
very high frequency

VMC
visual meteorological conditions

water pileup
A rise in the sea level of a nearly enclosed body of water due to prolonged strong winds from a constant direction. (Glossary of Meteorology)

weather minimum
The worst weather conditions under which aviation operations may be conducted under either visual or instrument flight rules. Usually prescribed by directives and standing operating procedures in terms of minimum ceiling, visibility, or specific hazards to flight. (JCS Publication 1-02)

WETM
weather teams

WN
WNINTEL (warning notice--intelligence sources and methods involved) [warning notice]

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